The Journal of Parasitology

Volume 26 December Supplement, 1940

PROGRAM AND ABSTRACTS OF THE SIXTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF PARASITOLOGISTS

PHILADELPHIA, PENNSYLVANIA

DECEMBER 30 and 31, 1940, and JANUARY 1, 1941

PROGRAM[1]

MONDAY MORNING SESSION, DECEMBER 30, 9:30 A.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Read

1. A Field Study of *Leucocytozoon bonasae* Clarke in Juvenile Ruffed Grouse, *Bonasa umbellus*. (12 min) (Lantern) EARL C. O'ROKE, University of Michigan.

2. Duodenal Mucus of Fowls as a Nematode Growth Inhibitor. (10 min) (Lantern) J. E. ACKERT AND LYMAN P. FRICK, Kansas State College.

3. Intestinal Goblet Cells and Age Resistance to Parasitism. (6 min) (Lantern) (Also by demonstration) J. E. ACKERT AND S. A. EDGAR, Kansas State College.

4. Studies of Phenothiazine and Related Substances as Anthelmintics. (12 min) PAUL D. HARWOOD, ROBERT T. HABERMANN, AND JAMES E. GUTHRIE, U. S. Bureau of Animal Industry.

5. The Influence of Biological Variation and Dosage-time-mortality Relationships on Anthelmintic Testing. (12 min) (Lantern) (Also by demonstration) JOHN H. WHITLOCK, Kansas Agricultural Experiment Station.

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[1] An alphabetical author index will be found at the end of this program, following which is the program (without abstracts) of a Symposium on Human Malaria.

Extra copies of this Supplement, and portraits of parasitologists, will be on sale at the meeting.

6. Some Effects of Short Starvation Periods upon the Fowl Cestode *Raillietina cesticillus* (Molin). (10 min) (Lantern) W. M. Reid, Kansas State College.

7. The Occurrence of *Dioctophyme renale* in Dogs of North Carolina. (12 min) H. W. Brown, A. J. Sheldon, and W. W. Taylor, Jr., University of North Carolina.

8. *Cephenomyia* in Virginia Deer. (5 min) (Lantern) S. Hadwen, Ontario Research Foundation. (Introduced by the Secretary.)

9. In Vitro Conditions Favoring Ecdysis at the End of the First Parasitic Stage of *Haemonchus contortus*. (12 min) (Lantern) Norman R. Stoll, Rockefeller Institute for Medical Research, Princeton, N. J.

10. Studies on Bovine Gastro-intestinal Parasites: V. Immunity to the Stomachworm, *Haemonchus contortus*, with a Note on the Prepatent Period. (12 min) (Also by demonstration) Roy L. Mayhew, Louisiana State University.

11. Studies on Bovine Gastro-intestinal Parasites: VI. The Blood Picture in Stomachworm (*Haemonchus contortus*) Infections. (10 min) (Also by demonstration) Elaine T. Delaune and Roy L. Mayhew, Louisiana State University.

12. The Internal Parasites of Puerto Rican Cattle with Special Reference to the Species Found in Calves Suffering from "Tropical Diarrhea." (10 min) (Lantern) John S. Andrews, Puerto Rico Agricultural Experiment Station.

13. Host-Parasite Relations of *Moniliformis dubius* (Acanthocephala) in White Rats, and the Environmental Nature of Resistance to Single and Superimposed Infections with This Parasite. (12 min) (Lantern) Paul L. Burlingame and Asa C. Chandler, Rice Institute.

By Title

14. Advanced Cases of Trichostrongylosis in Calves Controlled by the Use of Yeast, Adjunct to the Anthelmintic Treatment. D. W. Baker, New York State Veterinary College.

15. Survival of Eggs of the Swine Ascarid in Cultivated Soil. L. A. Spindler, U. S. Bureau of Animal Industry.

16. Survival on Soil of Eggs of the Swine Thorn-headed Worm, *Macracanthorhynchus hirudinaceus*. L. A. Spindler and K. C. Kates, U. S. Bureau of Animal Industry.

17. Treatment of Canine Heartworm (*Dirofilaria immitis*) with Fuadin and Sulfanilamide. H. W. Brown, University of North Carolina, and A. J. Sheldon, Harvard Medical School.

18. *Crenosoma mephitidis* in Dogs. M. Hobmaier, Hooper Foundation for Medical Research, University of California.

MONDAY AFTERNOON SESSION, DECEMBER 30, 2:00 P.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Read

19. Permanent Stained Preparations of Thick Blood Films. (10 min) (Also by demonstration) WENDELL D. GINGRICH, School of Medicine, University of Texas.

20. Studies on Human Intestinal Parasite Infections among Patients of an Indiana State Hospital. (12 min) (Lantern) WILLIAM B. HOPP, Purdue University.

21. Further Studies on Human Intestinal Parasite Infections among Residents of Indiana. (12 min) (Lantern) WILLIAM HUGH HEADLEE AND WILLIAM B. HOPP, Purdue University.

22. The Carrier Races of *Endamoeba histolytica* in a New Orleans Children's Institution. (12 min) (Lantern) ERNEST CARROLL FAUST, Tulane University.

23. Incidence and Diagnosis of *Trichomonas vaginalis* in a Non-clinical Group. (12 min) HERMAN A. SHELANSKI, University of Pennsylvania.

24. Studies on the Transfer of *Trichomonas hominis* from the Intestine to the Vagina in Man. (10 min) (Lantern) ROBERT M. STABLER, University of Pennsylvania, AND L. G. FEO AND A. E. RAKOFF, Jefferson Medical College Hospital.

25. A Study of Four Peruvian Strains of *Leishmania brasiliensis.* (12 min) (Lantern) (Also by demonstration) QUENTIN M. GEIMAN, Harvard Medical School, and Instituto Nacional de Higiene y Salud Publica, Peru.

26. The Occurrence of Charcot-Leyden Crystals in the Lesions of Sparganosis. (10 min) (Lantern) (Also by demonstration) JUSTUS F. MUELLER, New York State College of Forestry.

27. Studies on Oxyuriasis. IX. The Familial Nature of Pinworm Infestation. (12 min) (Lantern) (Also by demonstration) ELOISE B. CRAM, National Institute of Health.

28. Schistosomiasis in Venezuela. (12 min) (Lantern) J. ALLEN SCOTT, Instituto Nacional de Higiene, Venezuela.

29. A Preliminary Report of Human and Equine Encephalitis in Weld County, Colorado, in the Late Summer and Fall of 1940. (12 min) (Lantern) CORNELIUS B. PHILIP AND HERALD R. COX, U. S. Public Health Service, AND JOHN H. FOUNTAIN, Weld County Health Office, Colorado.

30. Elimination of *Hymenolepis fraterna* from Mice by Administration of Atabrine. (10 min) (Lantern) JAMES T. CULBERTSON, College of Physicians and Surgeons, Columbia University.

31. Acute Trichiniasis with Special Reference to Diagnosis and a New Treatment by the Application of Heat to the Small Intestine. (12 min) (Lantern) (Motion Picture Projector) DÁMASO DE RIVAS, University of Pennsylvania.

By Title

32. Neutral Red Staining for the Selection of Viable Cysts of *Endamoeba histolytica* by Means of the Micro-isolation Apparatus. LEON JACOBS, National Institute of Health. (Introduced by W. H. WRIGHT.)

33. The Pathogenicity for Kittens of Four Strains of *Endamoeba histolytica*. LUCY V. REARDON, National Institute of Health.

34. A New Ciliate from a Coral of Tortugas. RALPH WICHTERMAN, Temple University.

TUESDAY MORNING SESSION, DECEMBER 31, 9:30 A.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Read

35. Further Studies on the Use of Alcohol-preserved Tissue as a Base for a Cultivation Medium. (10 min) E. CLIFFORD NELSON, State of Maine Department of Inland Fisheries and Game.

36. The Relation of Vitamins B_1 and B_6 to *Eimeria nieschulzi* Infection of the Rat. (12 min) ELERY R. BECKER, Iowa State College.

37. Some Gregarines of Pacific Coast Decapods. (12 min) (Lantern) GORDON H. BALL, University of California at Los Angeles.

38. Studies on *Gregarina blattarum* with Particular Reference to the Chromosome Cycle. (12 min) (Lantern) VICTOR SPRAGUE, University of Illinois and Marshall College.

39. Studies on the Types of Cells Infected by *Leucocytozoon*. (10 min) (Lantern) CLAY G. HUFF, University of Chicago.

40. Single-parasite Infections and Exoerythrocytic Schizogony in *Plasmodium circumflexum*. (10 min) (Lantern) FREDERICK COULSTON AND REGINALD D. MANWELL, Syracuse University.

41. Virulence and Exoerythrocytic Schizogony in Four Species of *Plasmodium* in Domestic Ducks. (10 min) (Lantern) FRUMA WOLFSON, Johns Hopkins University.

42. Modifications of *Plasmodium cathemerium* in Canaries, Ducks and Fowls. (10 min) ROBERT HEGNER, Johns Hopkins University.

43. The Effect of Intraperitoneal Injections of Carbon Ink on the Course of *Plasmodium lophurae* Infections in Chickens. (10 min) (Lantern) WILLIAM TRAGER, Rockefeller Institute for Medical Research, Princeton, N. J.

TUESDAY MORNING, DECEMBER 31, 11:15 A.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Presidential Address

44. The Morphology of Some Protozoan Parasites in Relation to Microtechnique. DAVID H. WENRICH, University of Pennsylvania.

TUESDAY NOON, DECEMBER 31.

12:30 P.M. PARASITOLOGISTS' LUNCHEON, Mezzanine, Hotel Philadelphian, 39th and Chestnut Streets.

1:30 P.M. ANNUAL BUSINESS MEETING.

TUESDAY AFTERNOON SESSION, DECEMBER 31, 3:00 P.M.; MEDICAL LABORATORIES, UNIVERSITY OF PENNSYLVANIA. (Tea will be served.)

By Demonstration

3. Intestinal Goblet Cells and Age Resistance to Parasitism. (Also read) J. E. ACKERT AND S. A. EDGAR, Kansas State College.

5. The Influence of Biological Variation and Dosage-time-mortality Relationships on Anthelmintic Testing. (Also read) JOHN H. WHITLOCK, Kansas Agricultural Experiment Station.

10. Studies on Bovine Gastro-intestinal Parasites: V. Immunity to the Stomachworm, *Haemonchus contortus*, with a Note on the Prepatent Period. (Also read) ROY L. MAYHEW, Louisiana State University.

11. Studies on Bovine Gastro-intestinal Parasites: VI. The Blood Picture of Stomachworm (*Haemonchus contortus*) Infections. (Also read) ELAINE T. DELAUNE AND ROY L. MAYHEW, Louisiana State University.

19. Permanent Stained Preparations of Thick Blood Films. (Also read) WENDELL D. GINGRICH, School of Medicine, University of Texas.

25. A Study of Four Peruvian Strains of *Leishmania brasiliensis*. (Also read) QUENTIN M. GEIMAN, Harvard Medical School, and Instituto Nacional de Higiene y Salud Publica, Peru.

26. The Occurrence of Charcot-Leyden Crystals in the Lesions of Sparganosis. (Also read) JUSTUS F. MUELLER, New York State College of Forestry.

27. Studies on Oxyuriasis. IX. The Familial Nature of Pinworm Infestation. (Also read) ELOISE B. CRAM, National Institute of Health.

45. Glycogenous Materials in Myxosporidian Spores. FRANKLYN F. BOND, Johns Hopkins University.

46. Parasitism in *Paramecium caudatum*. RALPH WICHTERMAN, Temple University.

47. The Use of Silver Albumose (Protargol) in Protozoological

Technique. R. M. Cole and M. F. Day, Harvard University. (Introduced by L. R. Cleveland.)

48. A Practicable Semi-permeable Capsule Suitable for Avian Malaria Studies. Frederick Coulston, Syracuse University.

49. Micro-isolation of *Endamoeba histolytica*. Charles W. Rees, National Institute of Health.

50. The Increase of Histamine-like Substance in the Blood of Rats Experimentally Infected with *Trichinella spiralis*. C. B. Hamann, Purdue University.

51. Culturing *Trichinella spiralis* in Vitro. I. Preliminary Experiments: A Basic Medium to Sustain Larvae Unchanged for Long Periods in Vitro. Arthur J. Levin, State University of Iowa.

52. The Effect of Roentgen Radiation on Embryonic Development of *Trichinella spiralis*. Arthur J. Levin and Titus C. Evans, State University of Iowa.

53. The Morphology and Early Development of the Microfilaria of *Foleyella brachyoptera* Wehr and Causey, 1939. Emil Kotcher, Johns Hopkins University.

54. An Unusual Case of a Sexually Mature Trematode from the Body Cavity of a Diving Beetle. Wiley W. Crawford, Blackburn College.

55. A Note on the Strigeid Trematodes of the Alligator, with Remarks on the "Prostatic" Gland. Elon E. Byrd, University of Georgia.

56. The Life Cycle of *Fibricola cratera* (Barker and Noll, 1915) Dubois, 1932 (Trematoda: Strigeata). Ashton C. Cuckler, University of Minnesota.

57. Studies on the Life History of a New Species of *Anisoporus* (Trematoda: Allocreadiidae). Arne V. Hunninen and Raymond M. Cable, Oklahoma City University and Purdue University.

58. Life History Studies and Specific Determination in the Trematode Genus *Zoogonus*. Horace W. Stunkard, New York University.

59. *Gastrodiscus hominis* as a Parasite of Rats in Java. J. H. Sandground, Lilly Research Laboratories, Indianapolis.

60. A Revision of the Subfamily Dicrocoeliinae Looss, 1899, with New Species from North American Birds. J. Fred Denton, Rice Institute.

61. *Acolpenteron ureteroecetes* n. g., n. sp., a Monogenetic Trematode from the Ureters of Black Basses. (Also read) Jacob H. Fischthal and Leonard N. Allison, University of Michigan.

62. The Mother Sporocysts of Three Species of Monostomes of the Genus *Notocotylus* (Trematoda). (Also read) E. C. Herber, Johns Hopkins University.

69. Six New Species of Avian Schistosomes from Wisconsin and

Michigan with a Description of the Life Cycle of One of Them, *Gigantobilharzia gyrauli* (Brackett). (Also read) STERLING BRACKETT, University of North Carolina.

70. Life-history of *Cercariaeum constantiae* Mueller (Trematoda: Brachylaemidae) from the Snail, *Campeloma.* (Also read) LEONARD N. ALLISON, University of Michigan.

71. The Life History of a Gorgoderid Trematode, Presumably of the Genus *Phyllodistomum.* (Also read) WILEY W. CRAWFORD, Blackburn College.

72. Further Studies on the Sterile Culture of Stages in a Trematode Life Cycle. (Also read) M. S. FERGUSON, Rockefeller Institute for Medical Research, Princeton, N. J.

82. Calcification in *Capillaria hepatica* Infections. (Also read) THEODOR VON BRAND, Catholic University of America, AND G. F. OTTO, Johns Hopkins University.

WEDNESDAY MORNING SESSION, JANUARY 1, 9:30 A.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Read

61. *Acolpenteron ureteroecetes* n. g., n. sp., a Monogenetic Trematode from the Ureters of Black Basses. (5 min) (Lantern) (Also by demonstration) JACOB H. FISCHTHAL AND LEONARD N. ALLISON, University of Michigan.

62. The Mother Sporocysts of Three Species of Monostomes of the Genus *Notocotylus* (Trematoda). (10 min) (Lantern) (Also by demonstration) E. C. HERBER, Johns Hopkins University.

63. Studies on the Morphology and Biology of a Psilostome Fluke. (10 min) (Lantern) SEYMOUR I. FELDMAN, University of Minnesota.

64. Early Stages in the Development of Strigeid Trematodes. (12 min) (Lantern) LOUIS OLIVIER, New York University, AND W. W. CORT, Johns Hopkins University.

65. Studies on the Migration and Development of *Alaria* spp. (Trematoda: Strigeata) in the Definitive Host. (10 min) (Lantern) ASHTON C. CUCKLER, University of Minnesota.

66. The Life History of *Phyllodistomum solidum* Rankin, 1937 (Trematoda: Gorgoderidae). (10 min) (Lantern) CHAUNCEY G. GOODCHILD, New York University. (Introduced by H. W. STUNKARD.)

67. Studies on the Life History of *Deropristis inflata* (Molin) (Trematoda: Acanthocolpidae). (12 min) (Lantern) R. M. CABLE AND A. V. HUNNINEN, Purdue University, Oklahoma City University and the Marine Biological Laboratory.

68. Studies on Two Species of Liver Flukes. (12 min) (Lantern) F. G. WALLACE, University of Minnesota.

69. Six New Species of Avian Schistosomes from Wisconsin and Michigan with a Description of the Life Cycle of One of Them, *Gigantobilharzia gyrauli* (Brackett) (10 min) (Lantern) (Also by demonstration) STERLING BRACKETT, University of North Carolina.

70. Life-history of *Cercariaeum constantiae* Mueller (Trematoda: Brachylaemidae) from the Snail, *Campeloma.* (12 min) (Lantern) (Also by demonstration) LEONARD N. ALLISON, University of Michigan.

71. The Life History of a Gorgoderid Trematode, Presumably of the Genus *Phyllodistomum.* (12 min) (Also by demonstration) WILEY W. CRAWFORD, Blackburn College.

72. Further Studies on the Sterile Culture of Stages in a Trematode Life Cycle. (12 min) (Lantern) (Also by demonstration) M. S. FERGUSON, Rockefeller Institute for Medical Research, Princeton, N. J.

73. The Life Cycle of a Pseudophyllidean Tapeworm from the Common Sunfish, *Lepomis gibbosus.* (10 min) (Lantern) GEORGE W. HUNTER, III, Wesleyan University, and KENNETH M. MACKENTHUN, College of Emporia.

By Title

74. The Relation of Physid and Planorbid Snails to the Life Cycle of the Strigeid Trematode, *Cotylurus flabelliformis* (Faust, 1917). W. W. CORT, Johns Hopkins University, LOUIS OLIVIER, New York University, AND STERLING BRACKETT, University of North Carolina.

75. Studies on the Morphology of a New Species of *Cystidicola* (Nematoda: Thelaziidae) from the Swim Bladder of the Lake Trout. FRANCIS M. WHITE, Purdue University.

WEDNESDAY AFTERNOON SESSION, JANUARY 1, 2:00 P.M.; THOMSON HALL, COLLEGE OF PHYSICIANS BUILDING, 19 SOUTH 22ND STREET.

Read

76. The Physalopterinae (Nematoda) of North America. (10 min) BANNER BILL MORGAN, University of Wisconsin. (Introduced by C. A. HERRICK.)

77. Soil Sterilization for Nematodes. (12 min) (Lantern) B. G. CHITWOOD, U. S. Bureau of Plant Industry, Babylon, N. Y.

78. Some Comparisons of Acanthocephala in Marine Fishes of the Atlantic and Pacific Coasts. (5 min) HARLEY J. VAN CLEAVE, University of Illinois.

79. Distribution of Branchiobdellids in Florida. (10 min) CLARENCE JAMES GOODNIGHT, Brooklyn College.

80. A Method of Evaginating Tapeworm Cysticerci. (9 min) (Motion Picture Projector) S. A. EDGAR, Kansas State College.

81. Tissue Response to Unencysted Larvae of *Taenia pisiformis* in

Rabbits. (10 min) (Lantern) A. Byron Leonard and Alice E. Leonard, University of Kansas.

82. Calcification of *Capillaria hepatica* Infections. (12 min) (Lantern) (Also by demonstration) Theodor von Brand, Catholic University of America, and G. F. Otto, Johns Hopkins University.

83. The Mechanics of Respiration in *Camallanus trispinosus*. (12 min) (Lantern) G. W. Wharton, Duke University.

84. Partial Control of Seasonal Variation in the Progeny Characteristics of a Pure Line of *Strongyloides ratti*. (12 min) (Lantern) George L. Graham, Rockefeller Institute for Medical Research, Princeton, N. J.

85. Immunity Produced in Rats by the Intestinal Phase of *Trichinella* Infection. (12 min) (Lantern) C. V. Anderson and A. Byron Leonard, University of Kansas.

86. Fractionation of Rabbit Serum Containing Anti-*Trichinella* Immune-body. (10 min) (Lantern) Evelyn Abrams Mauss, Johns Hopkins University.

87. The Precipitin Reaction Applied to Certain Problems in Parasitology. (12 min) (Lantern) Raymond W. Wilhelmi, New York University.

By Title

88. Beetle Supply in Experimental Fowl Taeniasis. J. E. Ackert and A. A. Case, Kansas State College.

89. A Further Note on the Cultivation of *Taenia taeniaeformis* Larvae in Vitro with a Preliminary Report on the Respiration of These Parasites. James H. Wilmoth, New York University and Brooklyn College.

90. The Effect of Host Vitamin E Deficiency on *Trichinella spiralis* Infections. Herman Zaiman, State University of Iowa.

91. The Infection of *Anopheles quadrimaculatus* with a Monkey Malaria Parasite, *Plasmodium cynomolgi*, and with an Avian Parasite, *Plasmodium lophurae*. L. T. Coggleshall, International Health Division, Rockefeller Foundation, New York. (Introduced by the Secretary.)

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SYMPOSIUM ON HUMAN MALARIA

PROGRAM OF SECTION N, A. A. A. S., ORGANIZED IN CO-OPERATION WITH THE AMERICAN SOCIETY OF PARASITOLOGISTS, AMERICAN SOCIETY OF TROPICAL MEDICINE AND THE NATIONAL MALARIA COMMITTEE

PHILADELPHIA, PENNSYLVANIA

DECEMBER 30 and 31, 1940, and JANUARY 1, 1941

PROGRAM[2]

MONDAY MORNING SESSION, DECEMBER 30, 9:30 A.M.; MITCHELL HALL, COLLEGE OF PHYSICIANS BUILDING, 19 S. 22ND STREET.

1. Introduction. MARK F. BOYD, The Rockefeller Foundation, Tallahassee, Florida.

2. The Distribution of Malaria in North America, Mexico, Central America and the West Indies. ERNEST CARROLL FAUST, Tulane University.

3. The Etiology of Malaria, *Plasmodium malariae*. G. ROBERT COATNEY AND MARTIN YOUNG, National Institute of Health, Columbia, S. C.

4. The Etiology of Malaria, *Plasmodium vivax*. REGINALD D. MANWELL, Syracuse University.

5. The Etiology of Malaria, *Plasmodium falciparum*. STUART F. KITCHEN, The Rockefeller Foundation, Tallahassee, Florida.

6. Detection of the Parasites and Differential Diagnosis in Either Cycle. AIMEE WILCOX, National Institute of Health, Washington, D. C., AND LUCILE LOGAN, The Rockefeller Foundation, Tallahassee, Florida.

7. General Morphology of Anophelines and Classification of the Nearctic Species. WILLARD V. KING AND GEORGE H. BRADLEY, Bureau of Entomology and Plant Quarantine, Orlando, Florida.

MONDAY AFTERNOON SESSION, DECEMBER 30, 2:00 P.M.; MITCHELL HALL, COLLEGE OF PHYSICIANS BUILDING, 19 S. 22ND STREET.

8. The Anopheline Mosquitoes of North America (Neotropical) as Definitive Hosts. WILLIAM H. W. KOMP, U. S. Public Health Service, Ancon, Canal Zone, AND LLOYD E. ROZEBOOM, Johns Hopkins University.

9. Factors Influencing Infection of *Anopheles* with Malarial Parasites. CLAY G. HUFF, University of Chicago.

[2] No abstracts.

10. Vectors (Experimental and Natural Infection; Epidemiological Evidence). James S. Simmons, Office of the Surgeon General, Washington, D. C.

11. Cyclical Variations in the Incidence of Malaria. Charles F. Craig, San Antonio, Texas.

12. Topographical and Geological Factors Influencing the Epidemiology of Malaria. Robert B. Watson, Tennessee Valley Authority.

13. The Epidemicity and Endemicity of Malaria. Lewis W. Hackett, The Rockefeller Foundation, Buenos Aires, Argentina.

14. The Rôle of Anophelines in the Epidemiology of Malaria. Robert Matheson, Cornell University.

Tuesday Morning Session, December 31, 9:30 A.M.; Mitchell Hall, College of Physicians Building, 19 S. 22nd Street.

15. General Consideration of the Infection in the Intermediate Host. Mark F. Boyd, The Rockefeller Foundation, Tallahassee, Florida.

16. *Vivax* Malaria. Warren K. Stratman-Thomas, University of Tennessee.

17. Quartan and *falciparum* Malaria. Stuart F. Kitchen, The Rockefeller Foundation, Tallahassee, Florida.

18. The Morphological Effect of Infection on the Human Organism. Paul Cannon, University of Chicago.

19. The Physiological Effect of Infection on the Human Organism. Henry E. Meleney, Vanderbilt University.

Tuesday Afternoon Session, December 31, 2:00 P.M.; Mitchell Hall, College of Physicians Building, 19 S. 22nd Street.

20. The Characteristics of Immunity in Malaria. W. B. Redmond, Emory University.

21. The Cellular Basis for Immunity in Malaria. William H. Taliaferro, University of Chicago.

22. Serological Reactions in Malaria. Lowell T. Coggeshall, The Rockefeller Foundation, New York City.

23. Cinchona Derivatives as Therapeutic Agents in Malaria. Erwin E. Nelson, Tulane University.

24. Synthetic Drugs as Therapeutic Agents in Malaria. Hans Molitor, Merck Institute of Therapeutic Research, Rahway, N. J.

25. Experimental Chemotherapy in Malaria. John Maier, The Rockefeller Foundation, New York City.

Wednesday Morning Session, January 1, 9:30 A.M.; Mitchell Hall, College of Physicians Building, 19 S. 22nd Street.

26. The Treatment of Malaria. Oscar W. Bethea, Tulane University.

27. Prophylaxis in Malaria. HERBERT C. CLARK, Gorgas Memorial Institute, Panama.

28. General Considerations in the Control and Eradication of Malaria. JUSTIN ANDREWS, Georgia State Department of Health.

29. Surveys on the Control and Eradication of Malaria. JOHN E. ELMENDORF, JR., Escambia County Health Department, Pensacola, Florida.

30. Methods Directed Against Adult Mosquitoes in the Control and Eradication of Malaria. DANIEL M. JOBBINS, Gorgas Memorial Institute, Panama.

31. The Housing Problem in the Control of Malaria. C. C. KIKER, Tennessee Valley Authority.

32. Drainage and Filling Methods for Mosquito and Malaria Control. NELSON H. RECTOR, Mississippi State Board of Health.

WEDNESDAY AFTERNOON SESSION, JANUARY 1, 2:00 P.M.; MITCHELL HALL, COLLEGE OF PHYSICIANS BUILDING, 19 S. 22ND STREET.

33. The Management of Water in Controlling Larval Mosquitoes. E. HAROLD HINMAN, Tennessee Valley Authority.

34. Petroleum Products for Mosquito Control. JOSEPH M. GINSBURG AND WILHELM RUDOLPHS, New Jersey Agricultural Experiment Station, New Brunswick.

35. Paris Green (Copper Aceto Arsenite) and Other Intestinal Poisons as Larvicides for Mosquito Larvae. MARSHALL A. BARBER, National Institute of Health, Savannah, Georgia.

36. Naturalistic Methods of Malaria Control. PAUL F. RUSSELL, The Rockefeller Foundation, Madras, India.

37. Adaptability of Control Measures to the Nearctic Fauna of *Anopheles* Mosquitoes. H. A. JOHNSON, National Institute of Health, Bethesda, Maryland.

38. The Adaptability of Control Measures to the Malaria Vectors of the Caribbean Region. H. W. KUMM, The Rockefeller Foundation, Baltimore, Maryland.

39. An Anti-malaria Program for Official Health Agencies. LOUIS L. WILLIAMS, National Institute of Health, Bethesda, Maryland.

ABSTRACTS

AMERICAN SOCIETY OF PARASITOLOGISTS' PROGRAM

1. *A Field Study of* Leucocytozoon bonasae *Clarke in Juvenile Ruffed Grouse,* Bonasa umbellus. Earl C. O'Roke, University of Michigan.

Supplementing observations made in previous years in the Upper Peninsula of Michigan, studies were intensified from June to September, 1940. Thirty-five broods of young birds were located, collections made, and blood samples taken. Numerous broods were re-located from time to time and survival noted. With the opening of the hunting season, October 1, a re-check was made. Thirty-four per cent of the broods were infected with *Leucocytozoon bonasae* Clarke. The earliest age at which infection appears in the blood of juveniles is between 10 and 20 days. There is a high correlation between infected mothers and infected young in her brood. Blackflies (*Simulium*) are believed to transmit the infection. Field evidence indicates that this parasite causes sickness and death of young grouse in the wild. Fifty-five per cent of the individuals in the coveys under observation during the summer are known to have survived until October 1. This study offers evidence that when the die-off in grouse populations occurs in young birds, the pathogenic protozoon *Leucocytozoon bonasae* may be responsible. However, the studies thus far have not been conducted at any time or place where a conspicuous die-off was evident. In fact, the population of young grouse in the summer of 1940 was higher than it has been in previous years when observations have been made.

2. *Duodenal Mucus of Fowls as a Nematode Growth Inhibitor.* J. E. Ackert and Lyman P. Frick, Kansas State College.

Results of experiments have indicated that a substance which may be responsible for the resistance of older chickens to the intestinal nematode, *Ascaridia galli* (Schrank), occurs in the duodenal mucus of the host. Tests with mucus taken from susceptible and resistant chickens, respectively, indicated that the mucus from younger susceptible individuals had little or no effect upon the worms, while that from older resistant chickens definitely inhibited the growth of the worms in vitro. It would be logical to infer that the inhibitory factor in the mucus is of the nature of an antibody. However, as the mucus was subjected to autoclaving at 15 pounds pressure for 20 minutes, any antibodies present probably would be destroyed. If the inhibitory factor in the mucus were dependent upon antibodies alone, autoclaved mucus should possess no inhibitory power. But this is not the case, for autoclaved mucus appears to be as effective as the unautoclaved material. Therefore, it appears that the resistance of the older chickens to *Ascaridia galli* is not due wholly to an antigen-antibody relationship, but partly to some chemical substance whose concentration and resultant effectiveness increase with the age of the chick. To determine whether the substance is soluble and filterable, tests were run which indicated that after prolonged washing, the filtrate was as potent as the unwashed mucus. Mucus washings passed through a Berkefeld filter were also found to contain the nematode growth inhibitor.

3. *Intestinal Goblet Cells and Age Resistance to Parasitism.* J. E. Ackert and S. A. Edgar, Kansas State College.

The repeated occurrence of fewer and shorter fowl nematodes (*Ascaridia galli*) in older than in younger chickens experimentally infected led to histological studies of the portion of the fowl intestine inhabited by these worms. Sections of the duodenum taken slightly posterior to the entrance of the bile ducts were prepared from chickens ranging in age from 2 to 320 days. Among the striking histological differences were the increases in the numbers of goblet cells in the older as compared with the younger chicks. Beginning with an average of 2.9 goblet cells per area of intestinal villus in the 2-day chick, the numbers increased gradually to 10.7 goblet cells per similar area in the 124-day chicken after which no further increase in goblet cells occurred. These increases in numbers of goblet cells with age

parallel closely the increases in the resistance of the growing chickens to the development of the duodenal worm, *A. galli*. The results of numerous experiments have shown that the resistance of chickens (White Leghorns) to the growth of these worms increases until an age of about 4 months. As the worms are subjected to the mucin from the goblet cells and as their growth in vitro is inhibited by the mucin from older chickens, it is probable that a relationship exists between the increased number of duodenal goblet cells and the developing age resistance to the worms. The phenomena of larger numbers of goblet cells and increase of resistance with age to intestinal nematodes have also been demonstrated in rats.

4. *Studies of Phenothiazine and Related Substances as Anthelmintics.* PAUL D. HARWOOD, ROBERT T. HABERMANN, AND JAMES E. GUTHRIE, U. S. Bureau of Animal Industry.

The successful use of phenothiazine as an anthelmintic in sheep (1939, J. Parasitol. **25** Suppl: 34; 36) suggested that the drug should be tested in other herbivores. Phenothiazine appears to be as effective for the removal of worms from goats as from sheep. In horses dosages of 50 grams are very effective for the removal of *Strongylus* and cylicostomes, somewhat effective for the removal of *Parascaris* but ineffective for the removal of *Oxyuris* and *Gasterophilus*. Other workers reported success in removing *Haemonchus, Ostertagia, Trichostrongylus, Bunostomum,* and *Oesophagostomum* from cattle and *Heterakis* from chickens, following administration of phenothiazine. Since compounds related to phenothiazine may prove valuable as anthelmintics, diphenylamine, xanthone, phenothioxine, and phenazine in large doses were given limited tests against *Ascaris* and *Oesophagostomum* in swine but exhibited no promise. However, diphenylamine has shown promise for the removal of *Trichuris* from dogs (Guthrie, 1940, Proc. Helm. Soc. Washington **7**: 84). To test diphenylamine further, 25 grams of the drug plus 5 grams of sodium bicarbonate were given to one sheep weighing 63 pounds. One *Trichuris* and 53 *Oesophagostomum* were recovered following treatment. Only 9 *Bunostomum* were recovered from the host at necropsy. As examination of eggs in the feces showed that this sheep was infected with *Haemonchus* and *Ostertagia* prior to treatment, probably these worms were removed by diphenylamine and subsequently destroyed by the digestive enzymes. Forty-seven grams of s-diphenylthiourea were quickly fatal to one sheep weighing 82 pounds.

5. *The Influence of Biological Variation and Dosage-time-mortality Relationships on Anthelmintic Testing.* J. H. WHITLOCK, Kansas Agricultural Experiment Station.

Biological variation giving a skew type of frequency distribution has been shown to exist in the reaction of drugs and biolytic agents with widely varying biological material including mammals and nemas. Previous investigations have also shown that it is possible to determine the relative efficacy of an unknown drug or dose by comparing its action with that of a standard drug or dose on the same sample population, but that it is impossible to compare drug action by means of unrelated tests made on different sample populations. The present in vitro tests with *Strongylus vulgaris* and copper sulphate confirm these findings and offer evidence of the complexity of the dosage-time-mortality relationships of a biolytic agent. A linear relationship has been established between the logarithm of the dose and the probit mortality, between the reciprocal of the time and the probit mortality, and between the logarithm of the dose and the reciprocal of the time in the reaction between copper sulphate and *Strongylus vulgaris*. The biological variation exhibited by both parasites and their hosts and the peculiar dosage-time-mortality relationships make it necessary for those testing anthelmintics to adopt methods already in use by pharmacologists, entomologists, and agronomists who are dealing with similar problems. These include: (1) the use of proper sampling technics and a standard drug or dose; (2) the use of appropriate statistical methods to isolate or account for biological variation. (Contribution No. 87, Dept. of Veterinary Medicine.)

6. *Some Effects of Short Starvation Periods upon the Fowl Cestode* Raillietina cesticillus (*Molin*). W. M. Reid, Kansas State College.

The fasting of chickens infected with cestodes may result in profound metabolic disturbances in the tapeworms. A starvation period of from 20 to 48 hours, including the over-night feeding intervals of the chicken, results in the breaking off of long chains of proglottids. That the loss of these proglottids is due to partial starvation of the parasite is indicated by comparative chemical analyses. The glycogen store in worms from chickens starved 20 hours is lowered to less than one-twelfth of that found in worms from normally fed chickens. For example, the glycogen store of 123 tapeworms from 4 chickens starved 20 hours gave glycogen values per chicken which ranged from 0.19 to 0.57 per cent of the wet weight of the worm (without a correction factor); while the glycogen values of 66 worms from 4 normally fed chickens ranged from 3.80 to 5.14 per cent per chicken. The mean glycogen value for the starved group was 0.36 ± 0.16 per cent as compared with 4.35 ± 0.58 per cent for the normally fed group. The results from these and similar tests indicate that when fowls infected with tapeworms are subjected to even short starvation periods, the metabolism of the cestodes is seriously affected.

7. *The Occurrence of* Dioctophyme renale *in Dogs of North Carolina.* H. W. Brown, A. J. Sheldon, and W. W. Taylor, Jr., University of North Carolina.

The geographical distribution in the United States of recorded canine cases of *Dioctophyme renale* is given, indicating widespread occurrence. From a limited area in North Carolina, 20 additional cases are reported by the authors who autopsied a total of 54 dogs. The infection rate of 37 per cent is the highest that has previously appeared in the literature. In 13 of the infected dogs parasites were found only in the body cavity, six of the dogs had the worms in the kidney as well as in the body cavity, and one had parasites only in the kidney. Invariably, in case of kidney infection, the right kidney only was infected. In no instance did the left kidney contain any worms. The parasitized kidney was enlarged to approximately four times the normal size with its parenchyma completely destroyed and the fibrous capsule enclosing a coiled mass of worms. Externally, the dogs evidenced no signs of discomfort or disease and seemed to be normal in every way. Examination of the body cavity of dogs with worms in this site revealed the liver and the omentum covered with a bloody exudate, with the worm usually attached to the diaphragm and coiled between the lobes of the liver. Although the kidney worm has not previously been reported in the literature from North Carolina, interviews with dog owners and veterinarians indicate that it occurs in other localities of the state. These endemic areas are characterized by an abundance of low swampy ground typical of that found along the coastal plain.

8. Cephenomyia *in Virginia Deer.* S. Hadwen, Ontario Research Foundation.

The species has been raised from larvae obtained from the retro-pharyngeal recesses of deer. This species is compared with the northern *Cephenomyia* of reindeer.

9. *In Vitro Conditions Favoring Ecdysis at the End of the First Parasitic Stage of* Haemonchus contortus. Norman R. Stoll, Rockefeller Institute for Medical Research, Princeton, New Jersey.

Production of ecdysis at the end of the first parasitic (3rd larval) stage of *H. contortus* has been studied under sterile conditions in relation to salt solutions and liver extracts, the determination of their optimum concentrations, and the best conditions of test. In incubated unsealed tubes a large proportion of the larvae will undergo ecdysis in Tyrode or three-salt Ringer solution in 3–5 weeks. Dilutions of $\frac{1}{4}$ to $\frac{3}{4}$ the concentration isotonic for tissue constitute the favorable range. Normal saline, even in considerable dilution, is toxic. In sealed tubes the same favorable range of dilution with Tyrode solution is apparent, with ecdysis proceeding sooner, being appreciable at 1 week, better at 2 weeks, excellent at 3 weeks. While

ecdysis is thus demonstrable in non-nutrient salt solutions, it begins more promptly if liver extract is present. There is considerable variability in potency of aqueous liver extracts from different sources. A good extract is effective at a concentration equivalent to 0.05–0.20 grams original liver in one ml medium. Greater concentrations usually kill the larvae before parasitic development takes place. Neither Tyrode solution nor the liver extract gives evidence of being a source of food for the larvae, which undergo ecdysis as a sort of "pupation" through utilization of endogenous reserves, and then die as young 4th stages if appropriate food is not present in the medium. A restricted oxygen supply in vitro appears to increase the rate and amount of ecdysis.

10. *Studies on Bovine Gastro-intestinal Parasites: V. Immunity to the Stomachworm,* Haemonchus contortus, *with a Note on the Prepatent Period.* Roy L. Mayhew, Louisiana State University.

The calves used in these experiments were kept under parasite controlled conditions, and inoculated with larvae cultured from eggs obtained from adult worms, or from calves previously inoculated. Control calves kept under the same conditions remained consistently free from parasites except *Strongyloides* sp., and stomachworms only have been recovered at post-mortem. Five animals have developed a complete or partial immunity as measured by egg counts and tested by reinoculation. Four animals eliminated almost all of the adult parasites, and two of these remained completely resistant to reinoculation, while two were partially resistant. The fifth animal developed a complete resistance which was indicated by becoming and remaining negative, even though reinoculated, for a period of three months. The immune reaction may be initiated by adult worms or by immature larvae in animals with egg count averages between 2.6 and 157 eggs per gram of sediment, in animals with from 4 to 10 weeks previous infection, and in animals 13 to 40 weeks old. The reaction is characterized by a sudden drop (within 1 to 5 days) in contrast to a gradual decrease over a period of months when the parasites die of old age. The prepatent period in our experiments has varied between 14 and 29 days, one animal each being positive at 14, 16, 24, 25, 27, 28, and 29 days, and two at 26 days after administration of larvae.

11. *Studies on Bovine Gastro-intestinal Parasites: VI. The Blood Picture in Stomachworm* (Haemonchus contortus) *Infections.* Elaine T. Delaune and Roy L. Mayhew, Louisiana State University.

Two of the heavily infected calves reported upon above showed decreases of a little more than 2 million erythrocytes on the fifth day after inoculation and the third calf showed a similar decrease on the sixth day. During the next 25 to 30 days, there is a further gradual decrease of 3 to 5 million, followed by a gradual increase during the next 3 to 4 months toward the preinoculation normal. There was approximately a 30 per cent decrease in the hemoglobin percentage in two animals and a 50 per cent decrease in the other during the 30 days following inoculation. There is an increase of 4 to 6 thousand in the total leucocyte count beginning 5 to 6 days after inoculation and lasting 7 to 10 days. This is followed by a decrease of 7 to 8 thousand during the next 2 to 4 days and by a further gradual decrease of 2 to 3 thousand during the next 2 to 3 weeks. There is then a progressive increase during the next 3 to 4 months toward the preinoculation normal. The time of lowest counts in both types of cells, it will be noted, was toward the end of the larval period. The range in variation in the counts after inoculation was increased as much as ten times in the leucocytes and four times in the erythrocytes over the preinoculation period. There was an increase in the monocyte and a decrease in the lymphocyte percentages. Higher eosinophile percentages were often obtained after inoculation, rarely above 7 per cent, however, as compared to 0 to 2 per cent in the control calves. Five lightly infected animals showed the same general, though less marked, changes as the heavily infected.

12. *The Internal Parasites of Puerto Rican Cattle with Special Reference to the Species Found in Calves Suffering from "Tropical Diarrhea."* JOHN S. ANDREWS, Puerto Rico Agricultural Experiment Station.

During a preliminary survey undertaken in order to ascertain the probable relationship between a condition known locally as "tropical diarrhea," which occurs frequently in calves in Puerto Rico, and infection with gastrointestinal parasites, 23 calves between 2 and 11 months old were examined. Twenty-two of these calves were slaughtered and examined for parasites at necropsy. The parasites recovered, listed in the order of the frequency of their occurrence, but without regard to the severity of the individual infections, are as follows: *Bunostomum phlebotomum* (77.3 per cent), *Oesophagostomum radiatum* (63.6 per cent), *Cooperia punctata* (54.5 per cent), *Haemonchus contortus* (50 per cent), *Trichuris ovis* (40.9 per cent), *Dictyocaulus viviparus, H. similis,* and *Moniezia* spp. (22.7 per cent), *Ostertagia ostertagi* (18 per cent), *Setaria labiatopapillosa, Strongyloides papillosus* and *Trichostrongylus axei* (13.6 per cent), *Capillaria longipes, C.* sp., *Cooperia curticei, C. pectinata, Syngamus laryngeus, Fasciola hepatica,* and *Eimeria zurnii* (9 per cent), *Cotylophoron cotylophorum,* and *T. colubriformis* (4.5 per cent). Eight of the 22 calves examined postmortem and the one calf not autopsied were found to be suffering from diarrhea. Three of the eight were heavily infected with *Cooperia punctata.* This and other species of *Cooperia* have previously been reported in association with parasitic enteritis of cattle. Two calves showed marked infections with *Eimeria zurnii,* a coccidium well known as the cause of "bloody" diarrhea. The four remaining animals of this group harbored relatively large infections of parasites composed of two or more species. One was infected with *H. contortus* and *B. phlebotomum,* one with *E. zurnii* and *S. papillosus,* one with *B. phlebotomum* and *O. radiatum,* and one with *B. phlebotomum, C. punctata* and *O. radiatum.* Since relatively heavy infections with gastro-intestinal parasites were found to be associated with "tropical diarrhea" and since the symptoms exhibited by calves suffering from this condition were similar to those shown by calves suffering from parasitic gastroenteritis, it appears that "tropical diarrhea," as it occurs in calves in Puerto Rico, may be caused, at least in part, by parasitic infection.

13. *Host-Parasite Relations of* Moniliformis dubius *(Acanthocephala) in White Rats, and the Environmental Nature of Resistance to Single and Superimposed Infections with this Parasite.* PAUL L. BURLINGAME AND ASA C. CHANDLER, Rice Institute.

The percentage establishment, rate of growth, duration of survival, and site of development of *Moniliformis dubius* in white rats was studied in primary and superimposed infections. No age differences were observed up to from 3 to 7 months of age, but marked differences were apparent between individuals and between litters. With few exceptions the susceptibility of rats to secondary infection was proportional to the susceptibility to primary infections, rats with more than the average number of primary worms tending to harbor more than the average number of secondary worms, and vice versa. Rate of growth, size, and survival were found to be closely correlated with the site of development. The effects of primary on superimposed infections with respect to number and size of worms are shown to be due to the superimposed worms being crowded out of the more favorable regions of the intestine and forced to develop in less favorable regions where growth and survival are adversely affected even in primary infections. The data suggest that natural resistance to primary infections and acquired resistance to superimposed infections are due to environmental factors comparable with those operating in the case of free-living animals, and have little or nothing to do with a true immunological response on the part of the host.

14. *Advanced Cases of Trichostrongylosis in Calves Controlled by the Use of Yeast, Adjunct to the Anthelmintic Treatment.* D. W. BAKER, New York State Veterinary College.

No abstract received.

15. *Survival of Eggs of the Swine Ascarid in Cultivated Soil.* L. A. SPINDLER, U. S. Bureau of Animal Industry.

Observations were carried out at Beltsville, Maryland, to ascertain the survival period of ascarid eggs in soil subjected to repeated cultivation. An area seeded in April, 1936, with feces of ascarid-infected swine was each spring and fall thereafter plowed to a depth of approximately 4 inches and planted to a grain crop. Before each plowing the viability of the eggs was tested by pasturing on the area for a period of 10 to 14 days susceptible pigs 10 to 12 weeks old. The pigs were then killed and the lungs and small intestine examined for ascarid larvae as follows: The lungs were first ground and then kept 4 hours in warm physiologic saline with frequent shakings to free the larvae which were later separated from the tissue by screening and sedimentation. Larvae and other contents removed from the small intestine by warm water applied under pressure were separated by screening and sedimentation. As adjudged by results of the semi-annual tests, eggs on the area remained viable approximately 4 1/3 years. Three pigs pastured on the area from August 10 to 21, 1940, harbored 750, 1,004, and 868 larvae, respectively, in the lungs, and 170, 420, and 92 larvae, respectively, in the small intestine. Littermate control pigs kept in cement-floored pens were not parasitized. The findings demonstrate that frequent cultivation of the soil was ineffectual either in destroying the viability of all the eggs or in scattering them sufficiently to render the area safe for pigs.

16. *Survival on Soil of Eggs of the Swine Thorn-headed Worm,* Macracanthorhynchus hirudinaceus. L. A. SPINDLER AND K. C. KATES, U. S. Bureau of Animal Industry.

Tests to ascertain the survival period of swine thorn-headed worm eggs on outdoor plots of clay, sand, and sandy-loam soil were carried out at Beltsville, Maryland. The experiment, begun April 10, 1936, involved eggs in feces on one series of plots located in direct sunlight and one series on shaded plots; two similar series of plots were seeded with eggs alone. At intervals of from 3 to 6 months tests were made of the viability of the eggs. The criterion for determining egg viability was the capacity of the contained larvae to infect an intermediate host, *Cotinus nitida.* Grubs collected from soil to which hogs had not had access for approximately 8 years were allowed to feed for a period of 10 days in soil from the various plots and the insects were then examined for the presence in the gut tissue of larvae of thorn-headed worms. As adjudged by the results of grub-feeding tests, although the number of viable eggs present on the various plots decreased slowly during the experiment, some eggs remained viable as long as 3½ years. As far as numbers of viable eggs are concerned, no significant difference between the various plots was noted throughout the experiment.

17. *Treatment of Canine Heartworm* (Dirofilaria immitis) *with Fuadin and Sulfanilamide.* H. W. BROWN, University of North Carolina. AND A. J. SHELDON, Harvard Medical School.

In an attempt to find a more safe, efficient and economical treatment for the dog heartworm (*Dirofilaria immitis*) than the use of fuadin alone, the possibility of a synergistic action between this drug and sulfanilamide was investigated. Various doses and combinations of these two drugs were tried. The combined fuadin-sulfanilamide course of treatment over 10 days resulted in the elimination of microfilariae from the blood stream of 5 out of 6 dogs. The sixth dog had its microfilariae count reduced 96 per cent. Four of the dogs, weighing 11–15 kilograms, were given 1.0 cc of fuadin daily in a single dose intramuscularly for the first 4 days and 1.5 cc for the last 6 days. The remaining two dogs, weighing 20 kilograms each, were given 1.5 cc of fuadin daily for the first 4 days and 2.0 cc for the last 6 days. The sulfanilamide dosage was 4–5 grains per kilogram weight of dog and was divided into two doses daily by mouth. Three of the dogs suffered from reactions characterized by moderate fever, loss of appetite, bilateral corneal

opacity and malaise. These reactions persisted for several days, but were not considered to be of sufficient severity to necessitate withdrawal of the drugs.

18. Crenosoma mephitidis *in Dogs.* M. HOBMAIER, Hooper Foundation for Medical Research, University of California.

When third stage larvae of *Crenosoma mephitidis* were fed to pups the larvae were recovered on the first day from the wall of the intestinal tract, and on the second day they were demonstrable in the tissues of the lungs. None were seen in mesenteric lymphatic glands. On the fourth day the third molt was in evidence. The sheath of the third stage ending in a minute spine enclosed the fourth stage larva, which ended bluntly. In this stage a clearer differentiation of the internal sexual organs was in progress. They measured from 620 μ to 900 μ in length. No free larvae of that stage were observed. At the beginning of the second week the last molt was seen. The tail of the sheath was similar to that of the fourth stage larva. The enclosed larvae presented internal as well as external sexual organs nearing completeness. The length of the nematodes varied from 1,400 μ in males and 2,160 μ in females. On the eleventh day many of the parasites had reached maturity. The circular ridges, however, at this time were not clearly discernible. Nineteen days after feeding of third stage larvae of *Crenosoma mephitidis* to pups first stage larvae appeared in their droppings. Third stage larvae were raised from this material and when fed to pups they likewise produced infections. The observations deserve further attention on account of the close relationship between dog and fox and that between *Crenosoma mephitidis* and *Crenosoma vulpis.*

19. *Permanent Stained Preparations of Thick Blood Films.* WENDELL D. GINGRICH, School of Medicine, University of Texas.

The various procedures of laking and fixing thick films before staining them yield relatively poorly stained preparations, and covering films (stained by the usual techniques for the diagnosis of malaria) with paraffin oil to prevent fading is inconvenient. Fixation of films in an alcoholic solution of one of the eosine-azure-methylene blue dyes following the usual laking and staining in Giemsa stain has been found to give very good results. Of several procedures found to be satisfactory the following one is recommended: (1) lake and stain the dried film in diluted Giemsa stain (1 to 3 drops of stock solution per cc of distilled water) for about 10 minutes or more, wash momentarily in distilled water and allow to dry; (2) immerse film (or slide) in May-Grunwald stain (0.5 gram in 100 cc absolute methyl alcohol) for 30 seconds, wash momentarily in distilled water and allow to dry. Parasites are well stained and appear the same in form as in films which are not fixed, but the polychromasia (bluish background) is altered so that the field is lighter (which may be advantageous for some purposes) and violet in color. Films of malarial blood prepared in this manner on clean, alkali-free slides and mounted in Diaphane are as good after two years as at the time of preparation.

20. *Studies on Human Intestinal Parasite Infections among Patients of an Indiana State Hospital.* WILLIAM B. HOPP, Purdue University.

A survey to determine the incidence of human intestinal parasitic infections was conducted at the Evansville (Indiana) State Hospital for the Insane. A total of 842 stools from a group of 771 patients was examined by both the direct smear and the zinc sulfate centrifugal flotation techniques. Of the persons examined, 457 were males and 314 were females. The parasites found, with their percentage incidences, were as follows: *Endamoeba histolytica,* 3.1; *Endamoeba coli,* 61.3; *Endolimax nana,* 30.7; *Iodamoeba bütschlii,* 3.8; *Giardia lamblia,* 1.8; *Chilomastix mesnili,* 8.4; *Trichomonas hominis,* 0.1; *Trichocephalus trichiurus,* 0.3; *Strongyloides stercoralis,* 3.2; *Enterobius vermicularis,* 7.3; *Hymenolepis nana,* 0.1, and *Heterodera radicicola,* 0.1. Of the 771 patients examined, 579, or 75.1 per cent, were parasitized by one or more species of protozoa, helminths, or both; 556, or 72.1 per cent, were infected with protozoa; 77, or 10.0 per cent, were infected with

helminths, and 56, or 7.3 per cent, were infected with both protozoa and helminths. In addition, perianal scrapings, collected by means of NIH swabs, were examined. Only 3, or 6.4 per cent, of the 47 persons examined by this method were found to be infected with *Enterobius vermicularis*. Sweepings and scrapings from the floors of bathrooms and dormitories were examined for ova and larvae of helminths. Ova of *Enterobius vermicularis, Syphacia obvelata,* and *Heterodera radicicola* were found. Both rhabditiform and filariform larvae of *Strongyloides stercoralis,* as well as numbers of adult and larval free-living species of nematodes, were isolated from some of the bathroom floors.

21. *Further Studies on Human Intestinal Parasite Infections Among Residents of Indiana.* WILLIAM HUGH HEADLEE AND WILLIAM B. HOPP, Purdue University.

Stool examinations were made of both rural and urban inhabitants of Indiana to determine the incidence of intestinal parasite infections. The fecal examinations were made by a combination of the direct smear and the zinc sulfate centrifugal flotation techniques. Rural studies included 185 individuals from 47 families of Montgomery, Warrick and Pike counties. Eighty-seven individuals were males, ranging from 10 months to 79 years of age, and 98 were females, 3 months to 56 years of age. The parasites found, with the percentage incidences, were as follows: *Endamoeba histolytica,* 3.8; *Endamoeba coli,* 33.5; *Endolimax nana,* 19.5; *Iodamoeba bütschlii,* 2.2; *Ascaris lumbricoides,* 0.5, and *Enterobius vermicularis,* 2.2. Ninety-five, or 51.4 per cent, were infected with one or more species of protozoa, or helminth, or both protozoa and helminth. Individuals from two urban areas were examined. These persons were from families of which some member was attending a public health nursing clinic or a city clinic. Of the 75 persons examined, 56 were under 15 years of age and 19 were above this age. The parasites noted, with the percentage incidences, were as follows: *Endamoeba coli,* 8.0; *Endolimax nana,* 6.7; *Iodamoeba bütschlii,* 1.3; *Giardia lamblia,* 8.0; *Enterobius vermicularis,* 1.3, and *Hymenolepis nana,* 1.3. One case of intestinal myiasis was noted, and one stool contained ova of *Heterodera radicicola.* Two persons were infected with helminths, and 17, or 22.7 per cent, were infected with one or more species of protozoa, or helminth, or both protozoa and helminth.

22. *The Carrier Races of* Endamoeba histolytica *in a New Orleans Children's Institution.* ERNEST CARROLL FAUST, Tulane University.

In an intensive intestinal parasite survey of 119 young children living in one institution in New Orleans, 6 fresh stool specimens from each child were examined by direct unstained, iodine-stained and hematoxylin-stained films and by zinc sulphate centrifugal flotation technic. Of the 66 individuals (55.4 per cent of the total examined) found positive for *E. histolytica* by all technics, 51 (77.3 per cent) were diagnosed by hematoxylin films. A study of the hematoxylin preparations has revealed five probably distinct racial types, as follows: (1) small race (5.6–8.9 microns), with one to several short or medium-length sausage-shaped chromatoidals, delicate karyosome and prominent chromatin beading within the nuclear membrane; (2) small race (5.1–7.3 microns), with many minute rice-grain chromatoidals usually massed in clusters, prominent karyosome and peripheral chromatin beading within nuclear membrane; (3) small race (5.9–7.8 microns), with long, narrow chromatoidals, delicate karyosome and peripheral chromatin beading; (4) medium-sized race (10.1–12.3 microns), with a few short, sausage-shaped chromatoidals, small karyosome and large, distinct peripheral chromatin beading; and (5) large race (av. 16.9 μ), found in only one individual, with long, rod-shaped chromatoidals. The consistency with which these races were recovered in successive stools of the same individual suggests their probable morphological constancy.

23. *Incidence and Diagnosis of* Trichomonas vaginalis *in a Non-clinical Group.* HERMAN A. SHELANSKI, University of Pennsylvania.

A study has been made of the incidence and diagnosis of *Trichomonas vaginalis* in a non-clinical group of over 300 females sent in by the W. P. A. authorities for

cervical smears for possible Neisserian infection and for blood tests for possible syphilis. In addition to these tests, smears and cultures were made for *Trichomonas vaginalis,* and the incidences of the three infections were compared. The patients were examined in the Gynecological Clinic of the Philadelphia General Hospital. Both white and colored females were examined. The incidence of *Trichomonas vaginalis* in the white females was 24.2 per cent and in the colored females 47.6 per cent. These percentages are similar to those obtained in a clinical group of patients reported by Buxton and Shelanski in 1936 in a survey conducted in the same clinic. Diagnosis of *Trichomonas vaginalis* was made by taking a cervical smear on a sterile cotton applicator, immersing in several cubic centimeters of saline solution and examining a drop of this suspension microscopically. The applicator was then inoculated into a tube of 0.1 per cent Loeffler-Ringer medium and incubated at 37.5° C for purposes of cultivating the organism. It was shown that despite the clinical symptoms present in most of the cases, treatment was not sought. Some of the cases were treated and after being cured for some time became reinfected. An examination of the husbands of these cases showed infection in the urethra and prostate. The evidence presented is interesting from the standpoint of determining incidence of infection of *Trichomonas vaginalis* in general population groups.

24. *Studies on the Transfer of* Trichomonas hominis *from the Intestine to the Vagina in Man.* Robert M. Stabler, University of Pennsylvania, and L. G. Feo and A. E. Rakoff, Jefferson Medical College Hospital.

Using human volunteers, implantation studies were carried out involving the inoculation of *T. hominis* from culture into the human vagina. Fifty women (25 positive and 25 negative for *T. vaginalis*) were employed and 151 implantations were accomplished. No single vagina ever became positive for the intestinal trichomonad. Cultures were made from 20 vaginas (10 positive and 10 negative for *T. vaginalis*) immediately after the routine implantation of *T. hominis.* In only one case did we fail to get excellent growth, indicating that the element responsible for the failure of *T. hominis* to grow in the vagina is not transferable to the culture tube. In order to show that the correct species of *Trichomonas* would live in vaginas previously failing to support *T. hominis,* 10 such vaginas were given a single swabbing each with material directly from a *T. vaginalis* donor. Although 2 remained negative, 8 became permanently positive for the vaginal species. A series of clean kittens, with controls, were given per os doses of the *T. hominis* cultures used in our vaginal inoculations. At autopsy, at least one animal for each strain of *T. hominis* used was found to have a typical intestinal infection of this species, thus showing that though our strains had been in culture for 466 and 424 days (200 and 181 culture generations) they were still capable of setting up an infection in the proper site in a susceptible animal. We conclude that the trichomonads of the vagina and intestine of man are of two distinct species.

25. *A Study of Four Peruvian Strains of* Leishmania brasiliensis. Quentin M. Geiman, Harvard Medical School and Instituto Nacional de Higiene y Salud Publica, Peru.

Sixty-nine cases of cutaneous and nine cases of mucocutaneous leishmaniasis, commonly called *utá* and *espundia* respectively, were studied in Peru. Thirty-nine cases of *utá* were suitable for attempts to discover and isolate the causative organism. Stained films from 5 patients and cultures from 4 were positive for *Leishmania brasiliensis.* Scrapings of cutaneous lesions were inoculated directly into white mice and one dog on two occasions. No infections resulted. Swiss mice, dogs and monkeys (*Macaca mulatta*) were given subcutaneous or intraperitoneal inoculations from cultures. No gross pathology was produced or found at autopsy of the mice but positive cultures of *Leishmania* were recovered from the spleen of three mice one month after intraperitoneal inoculation. One dog developed typical *utá* on the nose and ear from which organisms were recovered in stained films and cultures. A biopsy specimen from the infected dog's nose produced a lesion when implanted in the nose of a second dog. The relative infectivity of *L. tropica* (1 strain, iso-

lated in Algiers in 1928) and *L. brasiliensis* (4 strains) for the chorio-allantoic fluid of the developing chick embryo was determined. The fluid of 5–9 day embryos was easily infected with *L. tropica* and it contained great numbers of actively motile organisms at the end of 3–5 days. No invasion of the membranes and the blood stream occurred. Twenty-six serial passages were made during a period of four months. Initial inoculation of *L. brasiliensis* under identical conditions produced no massive infection but only a morphological change, loss of motility, and a survival of the original organisms to the second passage. No tissue or blood stream invasion was detected.

26. *The Occurrence of Charcot-Leyden Crystals in the Lesions of Sparganosis.* JUSTUS F. MUELLER, New York State College of Forestry.

Charcot-Leyden crystals have been reported by various authors as present in the stools in about 20 per cent of infections with *Endamoeba histolytica,* less commonly in certain types of intestinal helminthiasis, in the sputum in cases of paragonimiasis and bronchial asthma, and in the bone marrow in chronic leukemia. Typical whetstone-shaped crystals, resembling Charcot-Leyden crystals, have now been found in the lesions of sparganosis in man and monkey, being most commonly found scattered among the cellular elements, particularly the macrophages, forming the inner lining of the cysts and galleries, or at times free in the space surrounding the worms. These crystals vary in length from 20 to 90 microns, and occur most abundantly after the infection has reached a chronic state and the worms have become well walled-off. The crystals have not been found in the tissues of infected mice nor in fishes infected with the encapsulated plerocercoids of a species of *Diphyllobothrium* maturing in gulls. Charcot-Leyden crystals are commonly described as octahedral in form, but the present crystals, although unquestionably of the same nature as those found in amoebic dysentery, etc., are more correctly designated as hexagonal pyramids of the first order.

27. *Studies on Oxyuriasis. IX. The Familial Nature of Pinworm Infestation.* ELOISE B. CRAM, National Institute of Health.

During the past 4 years, by NIH swab examinations *Enterobius vermicularis* has been found in 42 per cent of 2,900 white persons and in 13 per cent of 1,100 negroes, in the general population of Washington, D. C., and vicinity. Analysis is here made of the extent of oxyuriasis in 320 families containing infected persons. In these families 1,525 persons were examined; 5,539 swabs were made, an average of 3.6 per person. Due to limitations in procedure, it was impossible to make a complete check of the incidence within the families; the findings indicate only the *minimum* extent of the infection. In the 286 white families, 72 per cent of the children and 36 per cent of the adults were positive; in the 34 negro families, 51 per cent of the children and only 7 per cent of the adults. Multiple cases in white families were the rule rather than the exception; in only 70 families was a single case found, whereas the remaining 216 families had an average of 3.4 positive persons per family. On the other hand, in slightly over one-half of the negro families only a single case was found. In 139 of 282 white families all children who were examined, a total of 355, were positive. One or more adults proved infected in 125 of 257 white families; both parents of infected children were positive in 48 families. Quantitative evidence is therefore furnished that oxyuriasis is frequently a familial infection.

28. *Schistosomiasis in Venezuela.* J. ALLEN SCOTT, Instituto Nacional de Higiene, Venezuela.

There are probably somewhere in the neighborhood of 30,000 persons in Venezuela infected with *Schistosoma mansoni.* The infection is practically coextensive with the distribution of the transmitting snail, *Australorbis glabratus,* and occurs only in districts where irrigation is in use. It is not present in all such districts, nor are the snails found exclusively in irrigation water. Nevertheless, it seems probable that if the snails were prevented from breeding in the irrigation systems, they could scarcely maintain themselves elsewhere. The infection is principally found in val-

leys of the mountain range which extends along the central part of the northern coast. In the east the few foci reported are apparently small and local. West of the basin of Lake Valencia the infection is not found because the intermediate host is replaced in the fauna by *Tropicorbis* sp., while in the higher mountains farther west no planorbid snail is common in the steeper valleys. Our examinations do not cover the great plains south of the mountains nor the regions beyond the Orinoco, but it seems certain that any foci in these areas must be extremely local. The prevalence of infection is somewhat variable but in many regions over 90 per cent of the males above 10 years of age are infected, while the proportion of females infected is usually slightly lower. Virtual elimination of the infection through snail control seems a definite possibility requiring only money and perseverance.

29. *A Preliminary Report of Human and Equine Encephalitis in Weld County, Colorado, in the Late Summer and Fall of 1940.* CORNELIUS B. PHILIP AND HERALD R. COX, U. S. Public Health Service, AND JOHN H. FOUNTAIN, Weld County Health Office, Colorado.

Thirty-five diagnosed cases of epidemic encephalitis, including three fatalities, were reported between August 6 and October 8, 1940, 17 from within Greeley, Windsor, and Plattville, the remainder rural or in small towns. Ages of affected persons ranged from 9 to 81 years, involving twice the number of males as females. The attack rate was 5.38 per 10,000 population. Two were Mexicans, or an attack rate of 2.27 in proportion to population. The only multiple family cases observed involved two brothers and a cousin, ages 10, 16 and 20, on farms 5 miles distant with simultaneous onsets. History of actual contact was elicited in only one instance, whereas another instance involved a nurse who had had care of a case the year previous. Epidemiological evidence lends support to the mosquito transmission theory. Of the known experimental carriers, most abundant mosquito taken in September was *Aedes dorsalis,* though a few *A. nigromaculis* and *A. vexans* occurred. Other biting flies present included three other species of mosquitoes, four midges, two muscids and one tabanid, all of unlikely importance as human pests. Laboratory tests on brain material of 2 cases, and of 23 convalescent serums are in progress, but preliminary tests do not indicate the virus of equine encephalomyelitis as the infectious agent involved in this epidemic, although some 50 horses were afflicted in close proximity, with the onset of disease as late as September 10. Continuous irrigation in much of the affected area complicates analysis of past and present precipitation records as affecting estimated mosquito abundance. History of at least some mosquito exposure among the general population, including patients, is almost universal.

30. *Elimination of* Hymenolepis fraterna *from Mice by Administration of Atabrine.* JAMES T. CULBERTSON, College of Physicians and Surgeons, Columbia University.

Hymenolepis fraterna can be eliminated from mice by administering atabrine to the animals. Tests involving 61 treated and 21 control mice indicate that 10 mg of the drug given per os for two successive days, or somewhat smaller doses given for prolonged periods, generally completely cure the infection. Doses of the drug too small to eliminate all of the parasites suppress egg production by the worms for a time thereafter, the egg production later being resumed. The favorable effects of atabrine upon one human case of *Hymenolepis nana* will also be briefly described.

31. *Acute Trichiniasis with Special Reference to Diagnosis and a New Treatment by the Application of Heat to the Small Intestine.* DÁMASO DE RIVAS, University of Pennsylvania.

Following a brief outline of the life cycle of *Trichinella spiralis* as a base for the logical interpretation of the nature of the disease in man, special emphasis is made of the most characteristic clinical symptoms and the up-to-date laboratory procedures, such as the detection of the parasite in pork, stomach contents, peripheral

blood, spinal fluid, bile drainage and the muscles of man for the diagnosis of the disease. The treatment is based not on the administration of any specific new drug or preparation, but on the direct application of glycero-sulphate solution, made of equal parts of glycerine and a 30 per cent solution of magnesium sulphate, followed by the flushing of the small intestine with hot salt solution through the duodenal tube at the duodenal temperature of 45° to 47° C. The parasites die in 5 to 10 minutes, without causing any appreciable pathologic changes in the intestine nor any undue discomfort to the patient. When this procedure is properly and timely applied the symptoms subside rapidly after the first or second treatment, and in the experience of the author, the mortality of the affection, which ranges from 20 to 60 per cent, is reduced to less than 1 per cent.

32. *Neutral Red Staining for the Selection of Viable Cysts of* Endamoeba histolytica *by Means of the Micro-isolation Apparatus.* Leon Jacobs, National Institute of Health.

The micro-isolation apparatus developed by Rees has made it possible to pick up and culture both stained and unstained cysts of *Endamoeba histolytica* to determine their viability. Instead of eosin, the less toxic stain, neutral red, has been employed. A dilution of neutral red in physiological saline 1:25,000 is adequate. Dead cysts absorb the stain in about an hour, and after 24 hours viable cysts can still be obtained. Five experiments have thus far been performed in an attempt to evaluate neutral red staining as a criterion of viability. In these, the cysts were washed free from bacteria and were then seeded into Locke's egg-rice medium with a known species of bacterium. The results were as follows: Of 54 cultures with unstained cysts, 31, or 57.4 per cent became positive; of 21 cultures with stained cysts, none became positive. These data allow only the conclusion that stained cysts are non-viable, but it is believed that the failure of some cultures seeded with unstained cysts to develop positives may be explained on the basis of other factors. In the last two experiments, sheep serum was added and 100 per cent and 78.6 per cent, respectively, of cultures with unstained cysts became positive. Other conditions, such as the age of the bacterial culture used, are being investigated because they appear to influence the results. It is believed that it will eventually be demonstrated that all unstained cysts are viable, and it is hoped that this technique will lead to a more accurate evaluation of work done with the eosin test.

33. *The Pathogenicity for Kittens of Four Strains of* Endamoeba histolytica. Lucy V. Reardon, National Institute of Health.

In November, 1938, at the Georgia State Hospital at Milledgeville, Georgia, 70 adult white females were examined for *Endamoeba histolytica* (Reardon, 1941) and an incidence of 49 per cent without objective symptoms was found. The findings suggested the pertinence of a study like that of Meleney and Frye (1939) of the pathogenicity for kittens of the strain or strains involved, possibly resulting in further clarification of comparative virulence of strains. Using the technique of Meleney and Frye, strains isolated from 4 of the above patients, designated Georgia strains 3, 10, 36 and 43, were tested for pathogenicity for kittens. The number of kittens inoculated and becoming positive for each strain were: strain 3, 0 of 29; strain 10, 6 of 28; strain 36, 2 of 24; strain 43, 3 of 25. Percentages of "takes" are low compared with those of Meleney and Frye but not all inocula had 20 amoebae per low power field. Pathogenic indices, low compared to those of Meleney and Frye, were: strain 10, 0.19; strain 36, 0.18; strain 43, 0.15. The low number of "takes" and the low pathogenic indices postulate the existence of a strain of low virulence harbored by the 70 patients examined.

34. *A New Ciliate from a Coral of Tortugas.* Ralph Wichterman, Temple University.

A new ciliate was found on the coral *Eunicea crassa* E. and H., one of the very common members of the Alcyonaria fauna found throughout the Caribbean region and especially abundant on the reefs about Tortugas, Florida. The organisms were

observed in abundance crawling slowly on the surface of living coral. The ciliate, an ecto-commensal, measures approximately 85 by 75 microns, is elliptical with broadly rounded ends; occasionally nearly circular. Observed laterally it is highly convex dorsally and only slightly concave ventrally. Cilia are completely lacking from the dorsal surface but on the ventral surface, they form a discontinuous circle. An arc of long, tightly-packed cilia is anteriorly placed, directly posterior to which are found two tufts of long cilia. On the side opposite the peristome is a curved ciliary plate from which emanate very long cilia. A cluster of 5 or 6 spines approximately 13 microns long are posteriad. An adoral zone of membranelles is well-developed, beginning at the right side and extending entirely around the frontal margin and entering the sunken peristome which runs fairly close to the posterior end of the body. A single vacuole is posterior. The organism appears to be one of the Hypotricha perhaps more closely related to the Euplotidae family. (A large band-like macronucleus so characteristic of that family, is present.) All of the many hypotrichs observed were closely packed with the yellowish-brown nearly spherical unicellular alga, *Zooxanthella*. The ciliates appear to live by utilizing the products of holophytic nutrition of these symbiotic algae. The complete paper is expected to be published shortly.

35. *Further Studies on the Use of Alcohol-preserved Tissue as a Base For a Cultivation Medium.* E. Clifford Nelson, State of Maine Department of Inland Fisheries and Game.

Ten different tissues of the frog have been used in tests comparing their relative effectiveness in a cultivation medium for *Nyctotherus cordiformis*. Liver and stomach were found to be most effective, kidney and lung next, spleen and intestine next and comparatively poor growth was obtained with muscle, ovary, brain and heart.

36. *The Relation of Vitamins B_1 and B_6 to* Eimeria nieschulzi *Infection of the Rat.* E. R. Becker, Iowa State College.

That the intensity of *Eimeria nieschulzi* infection, as measured by oöcyst counts, is susceptible to modification by manipulating the formula of the ration has been conclusively demonstrated. It has also been brought out that a ration which efficiently promotes host-growth may or may not provide favorable conditions for maximum coccidium development. These facts suggested the presence of more or less of a substance that directly or indirectly favored coccidium development. The name coccidibios was suggested for this hypothetical substance. In the process of seeking the identity of this substance, a number of crystalline vitamins have been tested. Vitamin B_1 actually depresses the number of oöcysts eliminated. When vitamin B_1 is limited, vitamin B_6 has been found definitely to promote oöcyst numbers. It may be that "coccidibios" is a complex, of which vitamin B_6 is one of the factors.

37. *Some Gregarines of Pacific Coast Decapods.* Gordon H. Ball, University of California at Los Angeles.

The gregarines described include a Porosporid (probably a species of *Nematopsis*) from the striped shore-crab, *Pachygrapsus crassipes*, a form from the intestine and digestive gland of the sand-crab, *Emerita analoga*, and an inhabitant of the digestive tract of the mud-crab, *Hemigrapsus oregonensis*. Various stages in the life histories of these parasites are reported. From morphological evidence, there seems to be a rather high degree of host specificity. Closely related decapods in the same environment are not infected by the same parasites. As was found with the decapod gregarines described previously, there is no evidence of injury to the hosts as the result of this parasitism.

38. *Studies on* Gregarina blattarum *with Particular Reference to the Chromosome Cycle.* Victor Sprague, University of Illinois and Marshall College.

Gregarina blattarum von Siebold is a cephaline gregarine of common occurrence in the mid-gut of *Blatta orientalis* Linnaeus and other cockroaches. The sporadins

usually become associated in syzygy while very small and immature. Each pair grows to a rather definite size and then encysts. After a series of nuclear divisions, gametes are formed on the periphery of each encysted individual. The pregametic divisions are mitotic and three small rod-shaped chromosomes are present. The isogametes unite in pairs in a characteristic manner which is suggestive of physiological differences between the two members of the pair. The resulting synkaryon contains six chromosomes, a haploid set of three having been contributed by each of the two pronuclei. Following syngamy there is a series of nuclear changes in the zygote which strikingly resemble those occurring in the auxocytes of metazoa. Very soon after karyogamy the six chromosomes assume a polarized arrangement and undergo synapsis and tetrad formation. In the anaphase of the first metagamic division three dyads go to each daughter nucleus. A second metagamic division accomplishes the separation of the two elements in each of the dyads and the result is four nuclei, each with a haploid complement of three chromosomes. It is thus seen that the zygote, being a meiocyte, is the only diploid stage, all others being haploid. A third metagamic division gives rise to eight ring-shaped nuclei which transform themselves into long rods. The latter are the nuclei of the eight sporozoites.

39. *Studies on the Types of Cells Infected by* Leucocytozoon. CLAY G. HUFF, University of Chicago.

Studies based on wet-fixed smears of the organs of domestic and mallard ducklings reveal that the early stages of the gametocytes inhabit lymphocytes, monocytes and stages intermediate between these two. The cells containing these early stages are most frequently encountered in the liver. A completely intergraded series of cells connects the newly invaded lymphocytes with the badly distorted cells occupied by the mature gametocytes. Sections of organs show forms which might be considered as schizogonic stages in the life cycle within the hepatic cells. The similarities between these and corresponding stages of *Haemoproteus* and *Plasmodium* are discussed.

40. *Single-parasite Infections and Exoerythrocytic Schizogony in* Plasmodium circumflexum. FREDERICK COULSTON AND REGINALD D. MANWELL, Syracuse University.

Despite the very considerable amount of study which has been given to the various problems associated with the occurrence of the pigment-free stages in malaria, the significance of these stages has been questioned by some, and much still remains to be discovered about them. In particular, it has not yet been possible to rule out completely the possibility that such stages were in reality those of some parasite other than malaria, and—granting that they were stages of the malaria life-cycle—their origin has remained uncertain. Can they originate only from the sporozoites, or from the erythrocytic stages, or do stages in the red cells originate from the pigment-free forms? To settle the question of significance and origin, experiments to test the possibility of obtaining infections from single parasites were undertaken, using *Plasmodium circumflexum*. The results proved positive in a number of cases, both when isolation of single infected red cells, using a Chambers micro-manipulation apparatus, was employed and when dilution methods were used to secure inocula containing one or a very small number of parasites. In general, infections obtained in this way were extremely light and occurred only after a long incubation period. None of the initial infections exhibited exoerythrocytic schizogony, but after a number of passages this type of schizogony reappeared and thereafter occurred quite regularly. Thus it is certain that the pigmented forms occurring in the erythrocytes can give rise to the pigment-free forms, but the delay in the appearance of the latter suggests that they only develop when the defensive mechanism of the host is severely taxed, as it is by a massive dose of parasites.

41. *Virulence and Exoerythrocytic Schizogony in Four Species of* Plasmodium *in Domestic Ducks.* Fruma Wolfson, Johns Hopkins University.

The course of infection with four species of *Plasmodium* was observed in a total of over 250 ducks belonging to Pekin and Muscovy breeds and weighing from 35 to 1,750 grams at the time of intravenous inoculation. *P. lophurae* caused the most severe infections, often killing the birds in from one to three weeks. Unlike the other three species, there was no age resistance in ducks to *P. lophurae*. The parasite number reached the usual 10,000 per 10,000 erythrocytes in an adult bird of 6 months weighing 1,750 grams. The highest number, about 19,000 parasites per 10,000 erythrocytes, was observed in a duck of 280 grams two days before its death and 7 days after its inoculation with about 1 cc of infected blood. At this time, 80 per cent of its erythrocytes were multiply infected. The erythrocytic infection in *P. elongatum* was very low (under 500 parasites per 10,000 erythrocytes), but deaths occurred. This was the only species in association with which exoerythrocytic stages were observed in the ducks. The difference between the exoerythrocytic stages of *P. elongatum* and those of *P. cathemerium* (observed only in canaries) was that only the former infected the thrombocytes of the circulating blood and only *P. cathemerium* produced numerous free schizonts found lying in tissues outside of the host cells. *P. cathemerium* in ducks was much less virulent than *P. lophurae*, producing at the most only 4,000 parasites per 10,000 erythrocytes in young ducks. *P. relictum* was still less virulent.

42. *Modifications of* Plasmodium cathemerium *in Canaries, Ducks and Fowls.* Robert Hegner, Johns Hopkins University.

Two strains of *P. cathemerium* obtained from a sparrow and a wood thrush have lived in canaries several years. When transferred from canaries to ducks certain modifications have been observed. In canaries synchronicity is high; in ducks it decreases from day to day until it becomes low. In canaries the daily peak in parasite number occurs about 9 PM, in ducks about 5 AM, and in fowls about 9 AM. In canaries about 7 per cent of the parasites are gametocytes, in ducks, about 17 per cent. In canaries 5 per cent of the macrogametocytes are elongated, in fowls 10 per cent, and in ducks 57 per cent. The mean number of merozoites per segmenter is 11.2 in canaries, 7.9 in ducks and 5.0 in fowls. The length of the asexual cycle is 24 hours in canaries and ducks, and 48 hours in fowls.

43. *The Effect of Intraperitoneal Injections of Carbon Ink on the Course of* Plasmodium lophurae *Infections in Chickens.* William Trager, Rockefeller Institute for Medical Research, Princeton, N. J.

In chickens one to two months old, and weighing about 200 to 350 gm. *P. lophurae* ordinarily produces mild infections, even if large numbers of parasites are inoculated intracardially. The peak in the parasite number usually occurs not later than the third day after inoculation, and by the fourth day the number of parasites is markedly decreased and young red blood cells appear, their number varying directly with the severity of the infection. In similar chickens which have received, into the posterior peritoneal cavity, several large doses of carbon ink diluted in 0.85 per cent salt solution, the rate of increase of the parasites during the first three days is about the same as in untreated chickens. But the parasites continue to increase in number after the third day and reach a peak usually on the fifth or even the sixth day, after which the typical crisis occurs and the parasites are rapidly removed from the circulation. In spite of considerable individual variation, the peak number of parasites in ink-treated birds was almost always much higher than in controls, and figures of 3,000 to 5,000 parasites per 10,000 red blood cells were frequently obtained.

44. *The Morphology of Some Protozoan Parasites in Relation to Microtechnique.* David H. Wenrich, University of Pennsylvania.

Presidential address.

45. *Glycogenous Materials in Myxosporidian Spores.* Franklyn F. Bond, Johns Hopkins University.

The presence of a glycogenous vacuole in the spores of the family Myxobolidae (Sporozoa: Cnidosporidia) has long excited interest. This vacuole, presumably serving as a food storage body, is known to contain a polysaccharide material giving the characteristic glycogen reaction with iodine solutions. The lack of such a vacuole in other myxosporidian spores serving the same function as spores of the Myxobolidae, led to a series of studies aimed to determine the presence or lack of a similar food storage substance in spores of the other families of myxosporidia. Smear and section preparations were stained with Lugol's iodine, Best's carmine, and by the Bauer modification of the Feulgen reaction. Spore material of the family Myxosomatidae (*Myxosoma subtecalis* Bond and *M. funduli* Kudo) and of the family Myxidiidae (*Myxidium folium* Bond) was used in this study. Observed staining reactions, as compared to preparations stained after salivary digestion of the material, gave definite indications of glycogenous material in spores of the species studied. Bauer's technique was found to give the most accurate results on spore material. Best's carmine was found to be unable to penetrate easily the spore coat. Staining was obtained by the latter whenever the spore coat was cut in section or was only partially established. A diffuse staining reaction, ranging to particulate staining, was found throughout the sporoplasm of *M. subtecalis* spores. Staining reactions in the sporoplasm of *M. funduli* spores together with a much slower rate of salivary action suggested a similar though different polysaccharide content. Observations on *Myxidium folium* showed a high glycogenous content for the vegetative body, the reaction closely simulating that observed in the adjacent liver cells. Glycogenous material was abundant in the sporoplasm. In mature spores, staining material was grossly particulate and lodged in a definite pattern through the sporoplasm.

46. *Parasitism in* Paramecium caudatum. Ralph Wichterman, Temple University.

Enormous numbers of the parasites, which appear to belong to the genus *Holospora,* reside in a single compact mass exclusively in the macronucleus of *Paramecium caudatum,* distending that nuclear body until, at times, it fills up the entire organism. Heavily infected individuals move about very slowly, then settle on the bottom of the container and die. After death, the pellicle is ruptured and the parasites are liberated in the culture fluid. In severe epidemics, fully 80 per cent of the paramecia appear to be infected. The micronucleus is not parasitized but is generally pushed to one end of the animal. Fully-grown living parasites appear cylindrical and measure approximately 20 microns in length by 1.3 microns in width. Under dark-field illumination they show thick walls and thin blunt ends. They possess no movement of their own. Stained specimens show a small oval mass of chromatin at one extreme end. Division appears to be transverse but smaller forms with pointed ends suggest other stages in the life cycle. Attempts to grow the parasites in a *Paramecium*-broth and on agar plates proved unsuccessful although the parasitized paramecia have been kept in hay infusion cultures for over a year. Observations were also made on dividing parasitized paramecia and numerous experiments performed on reinfection. The full paper will include these results with drawings and photographs. The writer is greatly indebted to Professor D. H. Wenrich for the original culture of parasitized *Paramecium caudatum.*

47. *The Use of Silver Albumose (Protargol) in Protozoological Technique.* R. M. Cole and M. F. Day, Harvard University.

The reduced silver method (activated protargol) of Bodian (1937, Anat. Rec. 69) has been applied to coverglass preparations of protozoa. The results obtained warrant recommendation of the technique. Its main value to date is the very striking demonstration of the parabasal apparatus, especially in Trichonymphidae, Spirotrichonymphidae, and Trichomonadidae. It also renders flagella, undulating membranes (trichomonads, trypanosomes), and undulating cords (Pyrsonympha)

clearer than any other method. The triple nature of the undulating cords is shown for the first time. Whole mounts of *Paramecium caudatum* show a pattern of granules arranged in longitudinal lines. These appear double after formalin fixation but not after Schaudinn's, and are probably basal granules. Trichocysts also are outlined clearly, especially in sections. No pellicular pattern corresponding to that obtained by silver nitrate methods has been observed. Various fixatives may be used. Best results have been obtained after Schaudinn's and the formol-acetic No. 2 of Bodian. Hollande's differentiates nuclei more clearly; Flemming's and Zirkle's give poor results. The technique can be used for preparations previously stained by other methods and for those fixed and stored in alcohol for long periods, but the best results have been obtained by using freshly-fixed material.

48. *A Practicable Semi-permeable Capsule Suitable for Avian Malaria Studies.* FREDERICK COULSTON, Syracuse University.

Modifying the method of Harris (1939, J. Bacteriol.) a suitable semi-permeable capsule has been made that can be placed in the abdominal cavity of the canary. The frame work of the capsule consists of very fine stainless steel wire cloth. This is impregnated with Parlodion (10 per cent by weight) in glacial acetic acid. When filled, the capsule may hold 0.2 to 0.4 cc of fluid, depending on its size. The capsules may be fitted with a small glass tube which remains outside of the bird enabling entrance into the inside at any time. Birds are anesthesized with nembutal and an opening is made into the abdominal cavity. Into this the capsule and tube are placed and tied firmly to the body wall with sutures. On recovery, the bird is not hindered in any serious manner by either the capsule or the projecting tube. So far, over 25 birds have been so treated successfully. Capsules remain in canaries as long as two months after which time they are expelled gradually by the repair processes of the bird. Preliminary results with *Plasmodium circumflexum* indicate that the parasites may live and invade freshly supplied erythrocytes for as long as 17 days. No immunity has been produced in birds the capsules of which were filled every day for two weeks with enormous numbers of parasites. Gametocytes were recognizable for 9 days. A perfect exoerythrocytic stage was observed growing in one of the capsules after 10 days. Additional work is in progress.

49. *Micro-isolation of Endamoeba histolytica.* CHARLES W. REES, National Institute of Health.

The writer has perfected a practicable method of isolating cysts of *Endamoeba histolytica* free from bacteria, whether the cysts occur in culture or in human stools. A specially constructed micro-manipulator is used for this work, the cysts being picked out one at a time, washed thoroughly in as many changes of sterile physiologic saline as necessary and transferred to tubes of sterile culture media. Up to the present time, it has not been found possible to grow this amoeba without bacteria but it has been grown successfully with a number of pure species. In its present stage of development, the method serves to isolate *E. histolytica* from a flora containing an unknown number of species of bacteria, some of which may be pathogenic, and to grow it with a selected species of known characteristics.

50. *The Increase of Histamine-like Substance in the Blood of Rats Experimentally Infected with* Trichinella spiralis. C. B. HAMANN, Purdue University.

Improved methods of blood histamine estimation have been utilized in a study of experimental trichinosis in the albino rat. Thirty-two rats were infected, the dosages varying from 600 to 5,000 larvae each. After 14 to 16 days, the blood of experimental and control animals was tested for histamine, using either Code's modification of the extraction method of Barsoum and Gaddum, or Rosenthal's technique utilizing whole blood. Twenty-six of the infected rats showed significant increases in blood histamine as compared to controls tested on the same segments of guinea pig ileum. In preliminary experiments in which diluted blood of 7 rats (4 experimental and 3 control) was incubated with histaminase (T. 360–N, Win-

throp Chemical Co.), the ability to stimulate smooth muscle was destroyed, while blood incubated without histaminase retained its activity, indicating that the stimulating substance was histamine. A study is being made to determine whether there is any correlation between this histamine-like substance and the symptoms of acute trichinosis. The therapeutic value of histaminase is also being investigated.

51. *Culturing* Trichinella spiralis *in Vitro. I. Preliminary Experiments: A Basic Medium to Sustain Larvae Unchanged for Long Periods in Vitro.* ARTHUR J. LEVIN, State University of Iowa.

In attempting to carry out the life cycle of the obligatory parasite, *Trichinella spiralis,* in a synthetic environment, the first step seemed to be to determine a basic medium in which infective larvae will remain unchanged morphologically and physiologically for long periods of time. The next step would then be to add various chemicals or extracts which would cause the undeveloped larvae to mature sexually and produce progeny. Consequently, isotonic and anisotonic solutions of various combinations of salts were prepared, the larvae placed therein, and one set stored at 5° C, the other at 38° C. At 38° C larvae kept best in Tyrode's solution. Some remained alive up to 11 days, although sexual development did not occur in any case. At 5° C larvae in Tyrode's solution remained coiled and produced normal infections after periods up to four months, when this series of experiments was terminated. The second generation progeny of these same worms were also normally infective. The addition of Vitamin B complex seems to have had no effect whatsoever. Those solutions containing glucose seemed to be more beneficial over long periods.

52. *Effect of Roentgen Radiation on Embryonic Development of* Trichinella spiralis. ARTHUR J. LEVIN AND TITUS C. EVANS, State University of Iowa.

Previous investigations in this laboratory have indicated a lethal action of Roentgen radiation on the larvae of *Trichinella spiralis.* The purpose of this present study was to determine whether the radiation might have a selective action on the germ cells. Larvae, previously digested out of rat muscle, were subjected to various intensities of radiation and then fed, in known quantities, to rats. Five days after infection, intestinal counts of the number of trichina adults were made. The adults were also examined microscopically for possible injury to the embryos. It was found that after certain doses (around 2000 r) of radiation, the normal number of larvae could live and reach sexual maturity, although the embryos contained in the females were definitely retarded and injured. It is evident that the radiation affected the germ cells in such a way as to interfere with subsequent development. The possibility exists, then, of establishing an intestinal infection of adults without a consequent muscle invasion of their larvae. This selective action of irradiation may offer a new approach to the study of immunity.

53. *The Morphology and Early Development of the Microfilaria of* Foleyella brachyoptera *Wehr and Causey, 1939.* EMIL KOTCHER, Johns Hopkins University.

This microfilaria is found in two frogs, *Rana sphenocephala* and *R. pipiens.* The adult worms are found on the intestinal mesenteries and in the retroperitoneal cavity. The microfilaria is quite like other forms, is sheathed, and possesses an annulated cuticula. Heat-killed specimens measured 0.168×0.005 mm in normal saline. Morphological details are best discerned in wet preparations of methyl green pyronin. The mosquito, *Culex pipiens,* can serve as the intermediate host of this nematode. Microfilariae will undergo metamorphosis in the abdominal and thoracic regions, shed their sheaths by the end of the first day, and become sausage-stages, measuring 0.089×0.009 mm, by the fifth day at about 20 degrees C. The larva continues to develop going through the morphological changes of forming an esophagus, intestine and rectum. The G cells and anal pore of the microfilaria are observed to form the rectum and anus. The excretory cell and pore remain small and do not appear to form any structures during the development in the mosquito. The nerve ring, seldom definitely observed in the microfilaria, appears

at about the ninth day. The genital anlage also appears at about this time. Larvae recovered about the eighteenth day measuring 0.882 × 0.013–0.017 mm are very active and appear to be infective.

54. *An Unusual Case of a Sexually Mature Trematode from the Body Cavity of a Diving Beetle.* WILEY W. CRAWFORD, Blackburn College.

During the summer of 1939, a sexually immature trematode, genus *Allocreadium*, was found free in the body cavity of a diving beetle (*Dytiscus*), collected from a beaver pond near the Rocky Mountain Biological Laboratory, Crested Butte, Colorado. Measurements (in millimeters) were as follows: length, 1.52, width, 0.82, oral sucker, 0.156 × 0.182, ventral sucker, 0.174 × 0.217. Eye-spots were present lateral to the pharynx. July 11, 1940, two sexually mature trematodes of the same species, together with several hundred eggs, were taken from the body cavity of another diving beetle collected from the same pond. Measurements (in millimeters) of one specimen were as follows: length, 3.00, width, 1.35, diameter of oral sucker, 0.270, ventral sucker, 0.300, eggs on the average 0.089 × 0.068. No eye-spots were present. The eggs began hatching July 25. The miracidia averaged 0.087 × 0.045 mm in size and possessed a prominent eye-spot. Clams, *Psidium* sp., were infected with miracidia. A clam examined August 14 revealed several enlarged sac-like miracidia in the gills with two small eye-spots in place of the larger one. A second clam dissected September 7, showed two elongated minute-eyed sporocysts each containing one active immature redia. A third clam opened October 6, revealed several very active young eyeless rediae each containing immature cercariae. On July 15, a large quantity of eggs was recovered from the stomach of a second beetle. From the results, the question arises whether or not this is an unusual trematode whose life cycle involves but two invertebrate hosts.

55. *A Note on the Strigeid Trematodes of the Alligator, with Remarks on the "Prostatic" Gland.* ELON E. BYRD, University of Georgia.

During the past six years at least five species of strigeid trematodes have been collected from the alligator, *Alligator mississippiensis* (Daudin), from Georgia and Florida. These species appear to belong to three genera as follows: one species to the genus *Polycotyle* Willemoes-Suhm, one species to the genus *Pseudoneodiplostomum* Dubois and three species to the genus *Crocodilicola* Poche. Each of the five species shows a well-defined prostatic gland which is surrounded by variable masses of gland cells. In the genus *Polycotyle* the ejaculatory duct discharges directly into the uterus whereas in the genera *Pseudoneodiplostomum* and *Crocodilicola* this duct merges with the prostatic gland. In both cases the uterus and prostatic gland unite before opening to the outside at the apex of the genital cone. In none of our material does the uterus open to the outside separately from the prostatic gland. The gland itself becomes muscular after emerging from the genital cone and is lined with a cuticular-like material which often appears to be greatly thickened. In some of the material the gland is filled with a serous-like fluid containing sperm cells.

56. *The Life Cycle of* Fibricola cratera *(Barker and Noll, 1915) Dubois, 1932 (Trematoda: Strigeata).* ASHTON C. CUCKLER, University of Minnesota.

All stages in the life cycle of *Fibricola cratera*, a strigeid trematode of certain mammals, have been experimentally produced in the laboratory. Eggs hatch after 20–30 days incubation at room temperature liberating miracidia with 2 pigmented eyespots and 2 pairs of flame cells. Numerous elongate, thread-like sporocysts with subterminal birth pores develop in digestive glands of *Physa* spp. snails. Cercariae emerge from snails 25–28 days after exposure to miracidia. Cercariae have 2 unpigmented eyespots, 2 pairs of pre-acetabular penetration glands, ciliated patches in the principal collecting ducts, and a flame cell pattern of 2[(1 + 1) + (1 + 1 + 1) + (1)]. Cercariae develop into infective metacercariae in 30 days in the body cavities of several species of tadpoles. During metamorphosis of tadpoles the diplostomula migrate from the body cavity to the muscles of the hind legs where encapsulation

occurs. Metacercariae have very small, conical hindbodies; the forebodies are nearly as well-developed as in adults; there are no lateral sucking cups or ear lobes; the elliptical tribocytic organ is well-developed. Large numbers of diplostomula have been found in the fatbodies and muscles of garter snakes and Graham's water snakes. Diplostomula from frogs were transferred to the fatbodies and muscles of laboratory-born water snakes without undergoing any change. Metacercariae from tadpoles, frogs or snakes become adult worms in 8–10 days in the small intestines of rats, mice and cats. In very heavy infections in cats a few diplostomula migrate to the intercostal muscles and lungs and become encapsulated. Muskrats, brown rats, meadow mice, and a short-tailed shrew have been found infected naturally.

57. *Studies on the Life History of a New Species of* Anisoporus (*Trematoda: Allocreadiidae*). Arne V. Hunninen and Raymond M. Cable, *Oklahoma City* University and Purdue University.

The adult stage of a new species of *Anisoporus* was found in a number of marine fishes including the northern pipefish, *Syngnathus fuscus*, summer flounder, *Paralichthys dentatus*, killifish, *Fundulus heteroclitus*, and the four-spined stickleback, *Apeltes quadracus*. It differs from the two described species of *Anisoporus* in the size of the body, dimensions of the eggs (0.072–0.078 by 0.035–0.040 mm.), shape of the ovary, and number of papillae on the ventral sucker (three anterior, two posterior). The cercaria is a modified cotylomicrocercous form, developing in sausage-shaped sporocysts in the branchial region and digestive gland of *Murgis* [illegible]. It has a double-pointed stylet which is 0.011 mm long, and three pairs of cephalic glands with a lateral and two median ducts on each side. The tail is peculiar in that it does not form a hollow sucking cup but contains a mass of glands whose ducts converge to form a protrusible papilla, by means of which the larva may become firmly attached. The main ascending excretory tubules are ciliated and extend to the mid-acetabular level where each receives an anterior and posterior collecting tubule. The excretory formula is 2[(2+2)+(2+2)]; it remains unchanged during postcercarial development. The cercariae penetrate and encyst in the haemocoele of marine amphipods, particularly *Corophium tuberculatum* and *Amphithoe longimana*. The metacercaria increases rapidly in size from 0.1 to over 0.7 mm in cyst diameter. Adult structures become evident early in development and large metacercariae frequently contain eggs.

58. *Life History Studies and Specific Determination in the Trematode Genus* Zoogonus. Horace W. Stunkard, New York University.

Timon-David (1938) reviewed reports of metacercariae encysted in the sea urchins *Paracentrotus lividus*, *Sphaerechinus granularis* and *Arbacia pustulosa-lata* from the Mediterranean. Cysts were fed to *Blennius gattorugine;* the fishes were autopsied after 45 days and 12 sexually immature worms identified as *Zoogonus mirus* Looss, were recovered. Stunkard (1938) described the life history of an American species, identified as *Zoogonus rubellus* (Olsson) [illegible] *Z. parvus*, in which the larva *Cercariaeum lintoni* encysted in *Nereis virens* and developed to sexual maturity in fishes. During July and August, 1939 metacercariae apparently identical with those described by Timon-David, were found encysted in the sea urchin *Psammechinus miliaris* at Wimereux. This metacercaria has the same excretory formula as the American species. The larvae, however, are about twice as large as metacercariae from *Nereis* and there are certain morphological differences. Possibly the metacercaria from *P. miliaris* is conspecific with the tailless larva described by Stunkard (1932) as *Cercariaeum rubellum* from *Nereis vexillosa* at Roscoff. No cercariaeum was found in *N. pelagica* at Wimereux and no zoogonid metacercaria in the common polychaetes. In 1940, *Arbacia punctulata* and *Strongylocentrotus drobachiensis* at Woods Hole were exposed to *Z. lintoni*. No larvae were recovered from *S. drobachiensis*; they entered and encysted in *A. punctulata* but did not develop. Many died before encystment and others shortly thereafter. Study of the larval stages suggests that the European and American species of

Zoogonus are distinct and, in that event, the American form should be known as *Zoogonus lasius* Leidy, 1891.

59. Gastrodiscus hominis *as a Parasite of Rats in Java.* J. H. SANDGROUND, Lilly Research Laboratories, Indianapolis.

Gastrodiscus hominis first recorded as a parasite of man in Assam has subsequently been shown to occur in a high proportion of pigs in Indo China and other parts of India. An infection with this same species has been reported from the mouse deer of Malaya, *Tragulus napu.* It is now desired to extend the geographic range of this parasite to Java where we record it as occurring frequently in the cecum of a new host, the common field rat, *Rattus rattus brevicaudatus.* On the basis of comparative material from man and the pig, the parasite is identified as conspecific with *G. hominis.* A morphological study of an extensive series of worms supports the opinion expressed by Lane (1922 and 1924) that the characters whereby the genus *Gastrodiscoides* was created and differentiated from the predecessor genus *Gastrodicoides* are not valid.

60. *A Revision of the Subfamily Dicrocoeliinae Looss, 1899, with New Species from North American Birds.* J. FRED DENTON, Rice Institute.

A review of the trematodes assigned to the subfamily Dicrocoeliinae has permitted a revision of the subfamily diagnosis into which is incorporated not only adult characters, with the addition of the $2\times 6\times 2$ type of flame cell pattern, but also the following developmental characters: miracidia with stylet and two conspicuous vesicles containing refractile granules in posterior body region; sporocysts provided with birth canal; xiphidiocercariae with long slender tails, small stylets, and I-shaped excretory vesicles. Some of the older genera which were poorly defined have been rediagnosed with the subsequent reallocation of many species. Three new genera have been erected. A study of extensive material from North American birds and mammals has revealed 13 new species in birds, detailed descriptions of which will appear in another paper. *Eurytrema allentoshi* (Foster, 1939) is reported from opossums in the United States for the first time.

61. Acolpenteron ureteroecetes *n. g., n. sp., a Monogenetic Trematode from the Ureters of Black Basses.* JACOB H. FISCHTHAL AND LEONARD N. ALLISON, University of Michigan.

This unusual trematode, superfamily Gyrodactyloidea, occurs in the ureters and urinary bladder of large-mouthed bass, *Huro salmoides* and small-mouthed bass, *Micropterus dolomieu,* Huron River, Ann Arbor, Michigan.

Generic diagnosis: Monopisthocotylea. Head lappets, eyes and anchors absent. Haptor cup-like possessing 14 marginal hooklets. Sensory hairs arising from papillae. Testis single, elongated. Ovary elliptical, median. Vagina ventral, near right margin. Intestinal crura joined posteriorly, without diverticula.

Specific diagnosis: Acolpenteron. Adults, 0.931×0.105 mm. Haptor, 0.096×0.057 mm. Hooklets 0.023 mm long. Testis elongated, 0.053×0.016 mm. Seminal vesicle and coarse and hyaline prostates at left of cirrus, opening into it. Vas deferens left, looping over prostates. Cirrus (0.045 mm long) with forked accessory piece; male opening mid-ventral. Ovary (0.062×0.038 mm) thick posteriorly, thin anteriorly. Oviduct, yolk ducts and seminal receptacle uniting anterior to ovary. Mehlis' gland large, extending from oötype to anterior third of testis. Uterus opening near cirrus. Vagina bent, opening ventral, near right margin posterior to cirrus. Seminal receptacle present. Vitellaria voluminous, extending from pharynx nearly to haptor. Pharynx muscular, 0.047 mm in diameter. Esophagus short. Intestinal crura without diverticula, confluent posteriorly. Eggs (0.075×0.056 mm), operculate, anopercular process short, sharply bent and knobbed; hatching in water after 6–9 days. Larva (0.143×0.020 mm) ciliated, possessing 4 eyes and 14 hooklets on cup-like haptor; head lappets absent; swimming path a long spiral, rotating to the right.

Type and cotypes: U. S. Nat. Mus. Helm. Coll. No. 44301.

This new genus is closely related to *Calceostoma* and *Fridericianella,* family Calceostomatidae, which requires emendation to accommodate it.

62. *The Mother Sporocysts of Three Species of Monostomes of the Genus* Notocotylus (*Trematoda*). Elmer C. Herber, Johns Hopkins University.

Eggs of *Notocotylus quinqueserialis,* freshly shed in weak saline, were put into balanced aquaria containing specimens of *Gyraulus* sp. After a week's exposure, snails were dissected daily for evidences of mother sporocyst formation. Out of a total of 28 snails, 25 were infected with young larval stages while 3 had mature natural infections. Controls had a similar percentage of natural infections containing cercariae but no mother sporocysts. The first mother sporocyst was found on the 9th day after exposure. Most of the snails were heavily infected. One snail harbored over 30 mother sporocysts scattered along the intestines and in the mantle. All mother sporocysts of this species were found to contain 4 mother rediae. Cercariae, barely able to swim, were found in the digestive gland of a snail on the 26th day. On August 5th, eggs of *N. urbanensis* were transferred to aquaria containing laboratory raised juveniles of *Physa gyrina.* Only 4 of the 12 snails used in this experiment were positive. The first mother sporocyst was found on the 11th day. Some of these mother sporocysts contained 6, others 8 mother rediae. On August 21, one mother redia was found to contain cercariae as well as rediae. Eggs of an undescribed species of *Notocotylus* were placed with laboratory-raised juveniles of *Stagnicola emarginata angulata.* Every snail examined after the 10th day of the experiment was found infected with larval stages. Mother sporocysts were scattered along the intestines and in the mantle. The mother sporocysts of this species contain only one mother redia.

63. *Studies on the Morphology and Biology of a Psilostome Fluke.* Seymour I. Feldman, University of Minnesota.

During the fall of 1939 and the spring of 1940, cercariae were found in *Stagnicola palustris* in the vicinity of Minneapolis, Minnesota, which the writer identified as *Cercaria reflexae* Cort, 1914. Metacercariae were found naturally in the mantle cavity of *Physa gyrina* and *Stagnicola palustris.* These two snails and *Heliosoma trivolvis* were experimentally infected. The metacercariae were infective 5 to 7 days after penetrating the second intermediate host. The adult worm, *Psilostomum reflexae* (Cort, 1914) herein described, was found in the small intestine of laboratory reared chicks five days after feeding the metacercariae. Attempts were also made to infect several other birds and mammals, but without success. Miracidia were not observed, since the writer was unable to secure eggs in sufficient numbers in this abnormal host to follow through this stage of the cycle. Of 47 chicks fed metacercariae, 18 were infected with the adult worm, giving a 38.3 per cent infection with an average of 3.2 worms per infected chick. It seems apparent from these figures that the chick was an unsatisfactory host. The natural host of this trematode is as yet unknown. *Psilostomum reflexae* differs from *Psilostomum ondatrae* Price, 1931, in several details: the length of the esophagus, the distribution of the vitellaria and the type of intermediate host employed. The latter has an esophagus less than 0.1 mm long, whereas the former has an esophagus greater than 0.2 mm in length; in the latter the vitellaria extend to the level of the pharynx, and in the former to the level of the acetabulum; the latter uses fish and tadpoles as the second intermediate host, whereas the former utilizes several species of snails.

64. *Early Stages in the Development of Strigeid Trematodes.* Louis Olivier, New York University, and W. W. Cort, Johns Hopkins University.

Numerous mother and daughter sporocysts of strigeids were dissected from specimens of *Stagnicola emarginata angulata* (Sowerby) and studied in the living state. Mature and old mother sporocysts of four different species were obtained. They are elongate, mobile sacs with a thick wall and a terminal birth pore and ranged from 5 to 25 mm in length and from 0.13 to 0.32 mm in diameter. These

mother sporocysts contained daughter sporocyst embryos in various stages of development and a few irregular, many-celled structures (germ masses) but no single germ cells were seen in the cavity or on the walls. The germ masses are surrounded by a membrane and are made up of a number of many-celled components of different sizes and a few single-celled components which are located near the center of the mass. Apparently the largest components split off and become daughter sporocyst embryos. When they are about 1 mm long the daughter sporocysts leave the mother sporocyst. Just prior to emergence from the mother the daughters contain only germ masses which are similar to those found in mother sporocysts. At the time of emergence the groups of cells at the ends begin to split off from these germ masses. These ex-components are cercarial embryos which, like the daughter sporocyst embryos, appear to originate only in the germ masses. The latter persist throughout the life of the daughter sporocysts and are a constant source for cercarial embryos. Even in old and partly empty sporocysts, germ masses and the youngest cercarial embryos are still present.

65. *Studies on the Migration and Development of* Alaria *spp.* (*Trematoda: Strigeata*) *in the Definitive Host.* ASHTON C. CUCKLER, University of Minnesota.

Studies have been made on the development of *Mesocercaria marcianae* (La Rue) and *Mesocercaria intermedia* Olivier and Odlaug, 1938, larval strigeid trematodes occurring in the muscles of frogs. By artificial gastric digestion, the mesocercariae have been isolated from infected frogs and fed by pipette or stomach tube to laboratory reared kittens, white rats and mice. In rats and mice the mesocercariae penetrate the muscles and the mesenteric fat bodies where they develop into encysted metacercariae; these develop into adults in the intestines of cats in 7–10 days, in the same way as reported for *Alaria mustelae* Bosma, 1931. However, when mesocercariae are fed to kittens there is an active migration of the mesocercariae through the intestinal wall into the body cavity where they have been found as late as 26 days after infection. A few of the mesocercariae penetrate the intercostal muscles and develop into encysted metacercariae, but most of the mesocercariae pass through the diaphragm into the thoracic cavity, penetrate the lungs and stop in the alveoli where they transform into fully developed metacercariae 13 days after infection. These unencysted diplostomula migrate from the lung alveoli into the bronchi and up the trachea. Upon reaching the mouth the diplostomula are swallowed and finally, arriving in the intestine a second time, become sexually mature *Alaria* spp. 21 days after infection. These experiments demonstrate that only 3 hosts are necessary in the life cycles of these species of *Alaria,* and that a mammalian transport host may be interpolated but is not essential.

66. *The Life History of* Phyllodistomum solidum *Rankin, 1937* (*Trematoda: Gorgoderidae*). CHAUNCEY G. GOODCHILD, New York University.

Cercaria conica Goodchild, 1939 from *Pisidium abditum* Haldeman, when eaten by odonatan larvae penetrated the crop wall and encysted as metacercariae in the thoracic haemocoele. These metacercariae, after 24 hours, were infective for the final host, *Desmognathus fuscus fuscus* (Raf.). All stages in the life cycle have been experimentally produced. Eggs, which were passed with host urine into fresh water, hatched immediately, liberating free-swimming miracidia. These miracidia were drawn by water currents into the gills of the bivalve where they transformed into mother sporocysts. Mother sporocysts each produced a single generation of daughter sporocysts which gave rise to the large-tailed gorgoderid cercariae. From miracidial penetration to cercarial production required about three months. The vigorous cercarial activity served to lure odonatan naiads (*Ischnura verticalis* (Say), *Argia* sp., *Enallagma* sp., *Libellula* sp.) which are the metacercarial hosts. Within 4 minutes after ingestion by the naiad, cercariae have penetrated the crop wall and begun to encyst. Metacercariae excysted in the small intestine of the urodele and were recoverable in the posterior parts of the intestine, cloaca, and urinary bladder within 24 hours after ingestion of the odonatan naiad. In the laboratory, these bladder worms required at least 3 months to attain sexual maturity.

67. Studies on the Life History of Dendritis inflata *(Molin) (Trematoda: Acanthocolpidae).* P. M. Cable and A. V. Hunninen, Purdue University, Oklahoma City University, and the Marine Biological Laboratory.

The adults of *Dendritis inflata* occur in the intestine of *Anguilla rostrata*. The cercaria develops in simple rediae in the digestive gland of *Bittium alternatum* and encysts in *Nereis virens*. It is a modified trichocercous form, the tail bearing six apposed pairs of ventrolateral tubercles, each set with a delicate "hair"; smaller irregularly distributed tubercles may occur on the distal third of the tail. A short ventral fin-fold is present. The body contains at least eight pairs of cephalic glands with ducts both median and lateral to the eye-spots. Each main excretory tubule extends forward to the pharyngeal level where it receives an anterior and posterior collecting tubule. The anterior receives two secondary tubules, one extending forward to join the capillaries of three flame cells near the oral sucker, the other backward to join a similar group of flame cells between the eye-spot and ventral sucker. The posterior collecting tubule receives tubules from 5 groups of 3 flame cells each, the complete excretory formula being $2[(3+3)+(3+3+3+3+3)]$. The posterior ends of the main tubules are ciliated and the excretory vesicle contains refractile concretions. The cercaria swims almost continuously, tail first, and is strongly photonegative. After encystment in *Nereis*, little growth occurs, the most noticeable changes being dispersal of eye-spot pigment and development of the forebody spines characteristic of the adult. Since the summer flounder was found not to harbor natural infections of *D. inflata*, this fish was fed experimentally infected annelids and large numbers of young worms were recovered.

68. Studies on Two Species of Liver Flukes. F. G. Wallace, University of Minnesota.

Metacercariae of *Opisthorchis tonkae* Wallace and Penner and *Amphimerus elongatus* Gower have been found in minnows, principally *Pimephales promelas*. The metacercariae of the former agree closely with the descriptions of those of *Opisthorchis tenuicollis* and *Clonorchis sinensis*. When fed to mice by stomach tube they excyst in less than 10 minutes. In 20 minutes larvae are found in the bile duct and in 25 minutes a few larvae are found in the liver. The worms mature in nine days in the intra- and extrahepatic bile ducts producing pathological changes similar to those described for other liver flukes. *O. tonkae* matures in the mouse, rat, guinea pig, muskrat, dog, cat, and raccoon but not in the chick or duckling. *A. elongatus* migrates up the bile and pancreatic ducts and matures in the liver and pancreas of birds. In chicks the worms are found almost entirely in the liver while in ducks and pigeons the majority are found in the pancreas. A small proportion of the larvae administered matured in the liver tissue of mice where they produced changes markedly different from those produced by *Opisthorchis*. Pleurolophocercous distome cercariae with 14 penetration glands from *Amnicola limosa porata* develop in fish into metacercariae identical with those of *A. elongatus*.

69. Six New Species of Avian Schistosomes from Wisconsin and Michigan with a Description of the Life Cycle of One of Them. Gigantobilharzia gyrauli (Brackett). Sterling Brackett, University of North Carolina.

During 1940 many birds, chiefly those related to aquatic environments, were examined for schistosome trematodes. Six previously undescribed species were found. Four of these species, all belonging to the genus *Pseudobilharziella* Ejsmont, 1929, were taken from ducks collected in Wisconsin. The other two species are placed in the genus *Gigantobilharzia* Odhner, 1910. One of these was taken from ring-billed and herring gulls in Michigan and the other was taken from red-winged and yellow-headed blackbirds in Wisconsin. These new species will be demonstrated. The life cycle of the species found in blackbirds was determined when *Cercaria gyrauli* Brackett, 1940, developed in snails infected with miracidia of this worm in controlled experiments. Consequently this species becomes *Gigantobilharzia gyrauli (Brackett)*. This worm is only a little more than 50 μ in diameter but may be several centimeters in length. The males and females are similar in size

and shape. Besides being considerably smaller and having the sexes similar in size, this species also differs from *G. acotylea* Odhner, 1910, in having the oral sucker somewhat better developed, and in having the gynaecophoric canal better developed and placed at a greater distance back from the anterior end. It is unlike both *G. egreta* Lal, 1937, and *G. monocotylea* Szidat, 1930, since neither of these possesses a gynaecophoric canal.

70. *Life-history of* Cercariaeum constantiae *Mueller (Trematoda: Brachylaemidae) from the Snail,* Campeloma. Leonard N. Allison, University of Michigan.

Campeloma from Huron River and Honey Creek near Ann Arbor, Michigan, are heavily infected with *Cercariaeum constantiae* Mueller. These adolescariae were fed to various animals, and adults were recovered from the bursa Fabricii of chicks and ducklings and from the large intestines of raccoons. Three days after feeding, specimens contain eggs, but maximum egg production is reached at about 7 days; at 18 days degeneration of the worms is well along. Eggs are small and numerous, operculated, without processes, and embryonated when discharged but do not hatch in water. Adults are assigned to the family Brachylaemidae, as pointed out by Mueller in 1935 for the adolescariae. The genital pore is terminal and the testes and ovary are in the posterior fourth of the body. The cirrus is spined. The acetabulum is more than twice the diameter of the oral sucker. Experiments show that adolescariae develop from distomate, spined, furcocercous cercariae produced by branched-sporocysts massed in the digestive gland, kidney and uterine walls of *Campeloma.* The cercariae have a spinose acetabulum, ciliated excretory tubules, sensory hairs on body and tail, no eyespots and no finfolds on body or furcae. Furcae are slightly longer than the stubby tail-stem; excretory pores are at the tip of the furcae. Attempts at locomotion result in a "hovering" rather than in progressive swimming. The possession of a well-developed tail by the cercaria and the occurrence of the latter in an aquatic snail indicate that this species is probably an ancestral form of Brachylaemidae, and the presence of tail-furcae strongly suggests a relationship with Schistosomatoidea, Clinostomoidea and Strigeoidea.

71. *The Life History of a Gorgoderid Trematode, Presumably of the Genus* Phyllodistomum. Wiley W. Crawford, Blackburn College.

Life history stages of this trematode occurred in collections made during the summers of 1939 and 1940 from beaver and other ponds near the Rocky Mountain Biological Laboratory as follows: adults in the urinary bladder of the mountain toad, *Bufo boreas boreas,* and the tiger salamander, *Ambystoma tigrinum;* cystocercous cercariae in the clam, *Pisidium* sp.; metacercariae encysted in damsel fly naiads, caddice fly larvae and diving beetles. Infection experiments have been performed, demonstrating every step in the life cycle. Both damsel fly naiads reared from eggs and uninfected caddice fly larvae from East River readily ingested the large-tailed cercariae. A few days later recently encysted metacercariae were found adhering to the esophagus of each of the aquatic insects. Young toads reared from tadpoles were fed cysts from both naturally and laboratory infected caddice fly larvae and naturally infected diving beetles. From all of the experimentally fed toads thus far examined a high percentage of forms have been recovered from the urinary bladder 15 days or longer after feeding. The infective metacercariae do not enter the urinary bladder immediately but go first to the kidneys where they remain for about two weeks after which they appear in the urinary bladder, where they attain sexual maturity in five weeks. The eggs hatch in two days after being shed. Clams either secured from East River or laboratory reared were infected with miracidia.

72. *Further Studies on the Sterile Culture of Stages in a Trematode Life Cycle.* M. S. Ferguson, Rockefeller Institute for Medical Research, Princeton, N. J.

Further progress has been made in the sterile cultivation of the metacercariae of *Posthodiplostomum minimum.* Numbers of excysted metacercariae, when freed from microorganisms by a simplified washing method, developed into adult worms when

incubated in media containing a highly concentrated brewers' yeast extract. Although more nearly normal eggs were formed, none has been viable. Cercariae of this strigeid can be freed from microörganisms by a special method. These worms under natural conditions usually live about one day after emerging from the snail host but when introduced into sterile media have remained alive as long as one week. Changes similar to some of those occurring after cercariae infect the fish host have been noted in worms surviving in cultures.

73. *The Life Cycle of a Pseudophyllidean Tapeworm from the Common Sunfish,* Lepomis gibbosus. George W. Hunter, III, Wesleyan University, and Kenneth M. Mackenthun, College of Emporia.

During a survey of fish parasites of Connecticut in 1939 and 1940, a species of pseudophyllidean tapeworm, closely related to, if not identical with, *Bothriocephalus formosus* Mueller and Van Cleave, was discovered in the upper intestines and pyloric ceca of the common sunfish, *Lepomis gibbosus.* The life cycle of this tapeworm was determined experimentally. Eggs laid in an undeveloped stage hatch and liberate developed coracidia in 5–6 days. At least two species of copepods serve as the first intermediate host. The procercoids elaborate a cercomer in 9–10 days which is lost in 10–13 days after this ingestion of the coracidia. Yearling common sunfish from an uninfected locality yielded young plerocercoids in the upper intestine when fed infected copepods. Immature adults were recovered in three weeks. Experiments attempting to infect young of the yearling common sunfish, yearling chain pickerel, and yellow perch are in progress. All controls were negative.

74. *The Relation of Physid and Planorbid Snails to the Life Cycle of the Strigeid Trematode,* Cotylurus flabelliformis (*Faust, 1917*). W. W. Cort, Johns Hopkins University, Louis Olivier, New York University, and Sterling Brackett, University of North Carolina.

The cercariae of *Cotylurus flabelliformis* are found in certain lymnaeid snails. Lymnaeids are also the normal second intermediate hosts of this species and ducks serve as its definitive host. A series of experiments demonstrated that the metacercariae of this strigeid also developed in planorbid and physid snails that harbored the sporocysts and rediae of a number of different species of larval trematodes. The cercariae penetrate into uninfected snails belonging to these families but do not develop and soon die. The development of the metacercariae in such abnormal hosts takes place inside the sporocysts and rediae where the tetracotyle stage is reached more quickly than in the digestive glands of normal hosts. It is suggested that when the cercarial bodies penetrate into sporocysts or rediae, they are protected from any immune reaction of the abnormal host; also, as hyperparasites, they are able to utilize very effectively in their nutrition the food material which these trematode parasites have absorbed from the tissues of the snail host and have prepared for the nourishment of their developing progeny. Since the development of the metacercariae inside sporocysts and rediae in the abnormal host appears to be entirely normal, it seems very probable that physid and planorbid snails, which harbor larval trematode parasites, may have a regular part as second intermediate hosts in carrying out the life cycle of *C. flabelliformis.*

75. *Studies on the Morphology of a New Species of* Cystidicola (*Nematoda: Thelaziidae*) *from the Swim Bladder of the Lake Trout.* Francis M. White, Purdue University.

Examination of 40 specimens of *Cristivomer namaycush* from Flack Lake, Ontario, Canada, showed all of the fish to be infected with a new species of *Cystidicola.* Over 900 worms were removed from the swim bladder of one specimen. This new species of *Cystidicola* differs from described species in body length (males 15–21 mm, av. 19.7; mature females 23–32 mm, av. 26.7); the number of caudal papillae in the male (5–7 double pairs and one single pair of preanal and five pairs of postanal, the second and third forming a double pair); and particularly the nature of the eggs. They lack polar filaments and when fully formed, have a pair of con-

spicuous longitudinal mammillated ridges resembling superficially the floats on the eggs of anopheline mosquitoes. Such ridges have not been described for the eggs of other species of *Cystidicola*. Embryonated eggs measure 0.043–0.048 mm in length by 0.025–0.039 mm in breadth. This new species will be described more completely in a later paper.

76. *The Physalopterinae (Nematoda) of North America.* BANNER BILL MORGAN, University of Wisconsin.

Work is being carried on concerning the distribution, occurrence, and host-relationships of members of the subfamily Physalopterinae infecting animals of North America. The classification of Schulz (1927) is modified with the recognition of four genera: *Physaloptera* (Rudolphi, 1819), *Abbreviata* (Travassos, 1920; Schulz, 1927), *Skrjabinoptera* (Schulz, 1927) and *Pseudophysaloptera* (Baylis, 1934). The uteri groupings by Ortlepp (1922, 1937) namely, Didelphys, Tridelphys, Tetradelphys, and Polydelphys are followed instead of the subgenera proposed by Schulz (1927). Some of the Physalopterinae studied in this work include: *Physaloptera turgida* and *P. ackerti* from the opossum, *P. maxillaris* from the skunk, *P. clausa* from the grey fox, *P. felidis* from the cat, coyote, and red fox, *P. praeputialis* from the cat, dog, grey fox, and lynx, *P. variegata* from various snakes, *P. squamatae* from the water moccasin and brown lizard, *P. spinicauda* from various ground squirrels, *P. acuticauda* from the red-shouldered hawk, *Physaloptera* spp. from the raccoon and from dog and silver fox, *Physaloptera* sp. from various amphibia, *Physaloptera* sp. from the mole, and *Skrjabinoptera phrynosoma* from the horned toad. The above listed parasites in most cases were recovered from the stomachs of the various hosts.

77. *Soil Sterilization for Nematodes.* B. G. CHITWOOD, U. S. Bureau of Plant Industry, Babylon, N. Y.

Chloropicrin, ethylene chloride, and mixtures of these chemicals have been found to be effective in the sterilization of sandy loam soil against *Ditylenchus dipsaci* and *Heterodera marioni*, in muck soil against *Ditylenchus dipsaci* and in greenhouse soils against *Heterodera marioni*. There may be some differences in the efficacy of these substances and their mixtures, depending on the nematodes to be controlled. Increased plant growth has sometimes been observed. This is possibly due to reduction in soil organisms including not only nematodes but fungi and bacteria. Wetting the top inch of soil with water as a seal is considered essential for satisfactory sterilization. The treatment selected should depend on the value of the crop, the type of soil, and the organisms to be controlled. For *Ditylenchus dipsaci* in sandy loam, ethylene chloride at a cost rate of $110 per acre is considered recommendable; for *D. dipsaci* in muck soil, a mixture of chloropicrin-ethylene chloride at a cost rate of $294 per acre is recommended in the absence of data on ethylene chloride alone. For *Heterodera marioni* in sandy loam outdoors, ethylene chloride at a cost rate of $110 per acre is recommended though a mixture of chloropicrin-ethylene chloride (1.5 : 8.5) at a cost rate of $386 per acre gave still better results. For greenhouse use with expensive crops, mixtures of chloropicrin-ethylene chloride (1.5 : 8.5 and 1 : 9) at cost rates of $386 and $294 per acre respectively, and chloropicrin at a cost rate of $390 per acre have all given satisfactory results.

78. *Some Comparisons of Acanthocephala in Marine Fishes of the Atlantic and Pacific Coasts.* HARLEY J. VAN CLEAVE, University of Illinois.

In the Woods Hole region, Linton found *Serrasentis* and *Rhadinorhynchus* parasitic in *Cynoscion* but *Menticirrhus saxatilis* of that region, though closely related to *Cynoscion*, carried no acanthocephala. In the Gulf Coast, *Menticirrhus americanus* is type host of an acanthocephalan which has been described as *Illiosentis furcatus*. Extensive examinations of fishes of three species belonging to the croaker family were made at La Jolla, Cal., and in these a species of *Illiosentis* clearly distinct from *I. furcatus* has been found. Incidence of infections by this

species in *Menticirrhus undulatus, Roncador stearnsii,* and *Umbrina roncador* will be discussed.

79. *Distribution of Branchiobdellids in Florida.* Clarence James Goodnight, Brooklyn College.

Previously only *Cambarincola vitrea* has been reported from one locality in Florida. In order to further our knowledge of the distribution of these worms, a survey of the branchiobdellids of Florida was made. More than a hundred collections of worms were examined. These collections came from various localities well-distributed over the state. Four species in one genus were encountered. These four species were: *Cambarincola vitrea* Ellis, *C. philadelphica* (Leidy), *C. chirocephala Ellis,* and a new species. *C. vitrea* occurred throughout the entire state. *C. philadelphica* was widely distributed in the northern third of the state, but was entirely absent in the southern part of Florida. *C. chirocephala* occurred only in the northwestern part of the state, while the new species of *Cambarincola* was of very local distribution, being found only in a few adjacent localities in the northern part of the state. This study furnished additional evidence that in non-mountainous areas the number of species of branchiobdellids decreases as one goes south.

80. *A Method of Evaginating Tapeworm Cysticerci.* S. A. Edgar, Kansas State College.

A simple and effective method of providing evaginating cysticerci for experimental and class use is presented. The tapeworm larvae, *Cysticercus pisiformis,* were secured from the body cavity of the cottontail rabbit, *Sylvilagus floridanus mearnsii* (Allen). In extensive tests the cysticerci were placed in various concentrations of bile salts in Ringer's solution, physiological salt solution (0.75 per cent), distilled water, or tap water. The evaginations were most successful in the higher concentrations, especially those of 1 grain in 10 cc to 1 grain in 60 cc of solution. Following is the general method of procedure. Grind to a powder a 1 grain tablet of bile salts in a mortar; place this in 10 to 60 cc of any of the four solutions mentioned; filter after 5 minutes; warm with lamp to air temperature of about 98° F; then place bladder worms in the solution. Peristaltic-like movements of the cysticerci begin almost immediately and complete evagination usually occurs in less than 10 minutes, often in one minute. The cysticerci, which may be fresh or refrigerated for 3 or 4 days at 35° to 40° F, may either be whole or without bladders, as evagination proceeds similarly in either case. The hydrogen-ion concentration does not appear to be an important factor, since solutions adjusted to pH concentrations of 5.59 to 9.10 readily produced evaginations. In the higher concentrations of bile salts there was little choice between the salt and the water solutions, as all yielded prompt results.

81. *Tissue Response to Unencysted Larvae of* Taenia pisiformis *in Rabbits.* A. Byron Leonard and Alice E. Leonard, University of Kansas.

Artificially-hatched onchospheres of *T. pisiformis* were placed under the skin of actively and passively immunized rabbits and non-immune controls, and studies were made of the tissue response elicited by the presence of the larvae. The results indicate an entirely different type of cellular response in normal animals as compared with either actively or passively immune animals. In the former the initial response is essentially a polymorphonuclear leucocytic reaction, while in the latter the initial cellular reaction is dominantly a mononuclear leucocytic response. This significant difference is discussed in the light of the "early" and "late" immunity to *T. pisiformis* reported by Campbell (1938a, 1938b), and is compared with the results reported by Dienes and Mallory (1937) on their studies of the cellular reaction to tubercle bacilli in sensitive and non-sensitive guinea pigs.

82. *Calcification in* Capillaria hepatica *Infections.* Theodor von Brand, Catholic University of America, and G. F. Otto, Johns Hopkins University.

In rats infected with *Capillaria hepatica* calcium deposits were first noticed on the 19th day; such deposits were seen only in the amorphic detritus between the

worms and the connective tissue capsule. By the 27th day calcium deposits appeared in the worms themselves, but apparently only in worms which had previously died. Rarely were calcium deposits seen in eggs. Injections of fatal doses of parathormone failed to modify the process. However, in younger infections (5–15 days) calcium deposits were initiated by parathormone. This forced calcification was quite similar to the normal calcification in older infections but, in addition, involved liver cells which were never seen to calcify normally.

83. *The Mechanics of Respiration in* Camallanus trispinosus. G. W. WHARTON, Duke University.

Many parasitic worms possess respiratory pigments. The function of these has been thought to be the same as that in vertebrate animals. An attempt has been made to correlate the changes which the hemoglobin of *Camallanus trispinosus* undergoes with its respiration under varying environmental conditions in vitro. Because of the high concentration of hemoglobin in the body of the worm, it has been possible to determine the percentage saturation of this pigment with oxygen while it is in a respirometer. Experiments have been carried out under aerobic, partially anaerobic, and anaerobic conditions. When the oxygen tension of the saline in which the worms were tested approximates that of the atmosphere the hemoglobin is completely saturated. Under anaerobic or nearly anaerobic conditions the hemoglobin is completely reduced. When the oxygen tension of the saline solution is below 20 mm of mercury and above 1 mm, the pigment is proportionately and partially saturated. The rate of oxygen consumption of the worms under aerobic conditions at room temperature was found to be about 0.16 cubic mm of oxygen per worm per hour. The carbon dioxide production was such that the worms appeared to have an RQ greater than one. This might be caused by the release of a carbonate reserve. However, if the true RQ is greater than one, then the oxidizable substrate cannot be chiefly glycogen as is thought at the present time. The cuticle of *C. trispinosus* has been found to be permeable to oxygen.

84. *Partial Control of Seasonal Variation in the Progeny Characteristics of a Pure Line of* Strongyloides ratti. GEORGE L. GRAHAM, Rockefeller Institute for Medical Research, Princeton, N. J.

Seasonal variation in the frequency with which the progeny of singly established parasites in a pure line of *S. ratti* included heterogonic forms, i.e., free-living, bisexual adults, was recognized in 1936. Continued observation failed to reveal the associated causal factors in the nominal biological relationships of the rat host and the parasite, and led finally to the hypothesis that the environment of the host was in some way responsible for the changes observed in the reproductive performance of the parasite. Observations made since September, 1938, indicate that the seasonal variations can be considerably reduced by maintaining the rats, each infected with a single parasite, under controlled environmental conditions of 80–82° F and 62–68 per cent relative humidity. That the elements involved in the seasonal variations exceed those represented by these arbitrarily selected controlled conditions is shown by failure to maintain the relative frequency of indirect progeny at a uniform level during all periods of observation. Continuous records since January, 1935, show that the progeny characteristics in the pure line of *S. ratti* under consideration may not only vary from season to season but that progressive changes may occur from year to year.

85. *Immunity Produced in Rats by the Intestinal Phase of* Trichinella *Infection.* C. V. ANDERSON AND A. BYRON LEONARD, University of Kansas.

Rats infected with either male or female *Trichinella spiralis* develop a high degree of immunity although the infection is necessarily restricted to the intestinal phase. A series of animals was infected with an initial dose of 200–700 male or female *Trichinella* by duodenal transplants of worms segregated after recovery from the intestines of rats infected for 24 hours. Duodenal transplants were found to be necessary since it was discovered that, at this stage of development, *Trichinella* can no longer withstand passage through the stomach. Following a minimum period

of 22 days, the experimental and control animals were infected per os with 1,000 excysted larvae. Six weeks later all animals were killed and the larvae recovered by artificial digestion. The number of worms recovered from the experimental animals was significantly lower than from the controls.

86. *Fractionation of Rabbit Serum Containing Anti-*Trichinella *Immune-body.* EVELYN ABRAMS MAUSS, Johns Hopkins University.

The following observations suggest that the anti-*Trichinella* antibody present in immune whole serum is associated chiefly with the euglobulin fraction thereof, less closely with the pseudoglobulin fraction, and not at all with the albumin fraction: 1) When living *Trichinella* larvae are incubated in the different protein fractions of immune and normal sera, examination after incubation shows that only in those tubes containing immune whole serum and immune euglobulin, is there the abundant flocculum or circum-larval precipitate characteristically found in immune serum inoculated with larvae. The flocculum is less abundant, but present, in tubes containing immune pseudoglobulin. 2) Complement fixation tests in which normal and immune protein fractions and whole sera serve as antibody, and extract of *Trichinella* larvae (McCoy et al., 1933) as antigen, indicate that immune euglobulin fixes complement to a degree comparable with immune whole serum, and that immune pseudoglobulin fixes complement, but less markedly.

87. *The Precipitin Reaction Applied to Certain Problems in Parasitology.* RAYMOND W. WILHELMI, New York University.

When adequate precautions are employed in preparing antigens and antisera, and in determining titers, the precipitin reaction is of great practical value (1) in elucidating interrelationships of helminths, (2) in testing validity of questionable species, (3) as an aid in working life cycles and (4) in diagnosing helminthic infections. Earlier reports (Wilhelmi, 1939, 1940) indicated that reactions involving materials from several families of trematodes are in agreement with developmental and morphological comparisons. Evidence involves hostal relationships, structural characteristics (emphasizing those of larvae), and the presence or absence of certain larval stages in the cycle. The morphological and physiological observations suggest that the Plagiorchidae are the most primitive of the families under consideration and that from this group two lines of evolution have diverged, one comprising the Heterophyidae and Echinostomatidae, and the other, the Paramphistomidae. Though two species within a single genus were not tested, the uniformity of results and confirmation by reciprocal tests indicate that the technique will differentiate species. Since specificity of helminths is established early, at least by the time that the redia is formed, one can identify larvae with their adults. As previously reported, the minimum amount of antigen providing uniform rabbit antisera is 40 mg. of dry-weight, lipid-free material. Since confirmation by reciprocal tests is necessary before valid conclusions can be drawn, considerable material of *each* stage is necessary for extraction and injection. Hence, use of the precipitation technique in elucidation of life cycles will be determined by availability of materials. Much experimental work designed to use the technique in diagnosis of helminthic infection has depended on group specificity and has not allowed specific identification, such as is possible when lipid-free materials of known concentration are employed.

88. *Beetle Supply in Experimental Fowl Taeniasis.* J. E. ACKERT AND A. A. CASE, Kansas State College.

Chief among the reasons for the limited amount of experimental data on taeniasis has been the difficulty of obtaining, under laboratory conditions, a constant supply of larval tapeworms. This handicap in studying fowl taeniasis can be overcome largely by the use of Carabidae, especially for the tapeworm species *Raillietina cesticillus* (Molin). The larvae of this worm will develop in at least 30 species of 12 carabid genera; some of these species may develop large numbers of cysticercoids (up to 930) at one time. The ease with which these small spherical cysticercoids may be taken from the beetle makes this insect a valuable intermediate host in

experimental fowl taeniasis. The carabids, which must be taken some distance from poultry yards, are best collected immediately after a rain when quantities of them may be secured under bits of debris at the edges of walks and drives. These are cultured in glass jars containing moist (but not wet) soil. Those not needed at once may be refrigerated at from 45° to 50° F for several months, to be used during periods of dry or cold weather when the beetles are scarce. This method affords a constant supply of beetles during much of the year. Such beetles readily take the egg-filled proglottids of *R. cesticillus* whose cysticercoids develop in the body cavities of the beetles in about three weeks. Besides the Carabidae, genera of other families of beetles, notably the Cantharidae, Ostomidae, Scarabaeidae and Tenebrionidae, may also be used in experimental fowl taeniasis.

89. *A Further Note on the Cultivation of* Taenia taeniaeformis *Larvae in Vitro with a Preliminary Report on the Respiration of These Parasites.* JAMES H. WILMOTH, New York University and Brooklyn College.

Rats, mice and other rodents serve as intermediate hosts for the cat tapeworm, *Taenia taeniaeformis*. The larva (*Cysticercus fasciolaris*) of this tapeworm is normally found in cysts on the surface of the rodent liver. Several months is required for the larva to reach a stage infective for the final host. Usually such larvae are bacteria-free, an important principle in the choice of material for in vitro cultivation and respiration studies. An earlier note (1938, J. Parasitol., **24** Suppl. 35) reported that modified Tyrode's solution at 37° C served to keep these larval tapeworms alive for 14 days under oligoseptic conditions. Subsequently such larvae were maintained alive for periods of 16, 18 and 24 days in modified mammalian Ringer's and Tyrode's solutions. Measurements of oxygen consumption utilizing a micro-Winkler method were made for various groups of these larvae. Various concentrations of potassium cyanide in normal mammalian Ringer's solution produced a pronounced decrease in oxygen consumption when compared with controls. Data gathered on the effect of methylene blue, dinitrophenol, paraphenylenediamine and acriflavine on oxygen consumption were inconclusive and will have to be repeated. These substances generally have a tendency to increase respiration. Inhibitors of oxygen consumption such as narcotics and iodoacetate are being tried.

90. *The Effect of Host Vitamin E Deficiency on* Trichinella spiralis *Infections.* HERMAN ZAIMAN, State University of Iowa.

Since vitamin E is the sterility vitamin and lack of it may also cause muscular dystrophy, it is appropriate that its relation to infections with the muscle parasite *T. spiralis* be investigated. Thirteen experimental and 11 control rats were used. The experimental animals were kept on a synthetic vitamin E free diet for six months after being weaned. The controls were fed Purina dog chow. Each rat received 2,500 larvae. Two experimental and two control rats were killed six days after infection. Adult worms recovered from the intestines of the control animals numbered 1,825 and 1,900 respectively. The experimental rats had 1,950 and 1,750 worms. An equal number of rats was killed on the 16th day of infection. Examination revealed 0 and 350 worms in the controls while the experimentals harbored 0 and 800 worms. During the summer four control rats died and were refrigerated. When digested early in September dead worms made accurate counts impossible. Four months after infection the three remaining controls and the nine experimental animals were killed. No worms were found in any intestine. Muscle counts of the controls were 256,500, 133,000, and 236,000 larvae. In the experimental rats, muscle counts showed 129,000, 45,500, 194,500, 48,500, 69,000, 100,500, 47,500, 17,000 and 104,500 larvae.

91. *The Infection of* Anopheles quadrimaculatus *with a Monkey Malaria Parasite,* Plasmodium cynomolgi, *and with an Avian Parasite,* Plasmodium lophurae. L. T. COGGESHALL, International Health Division, Rockefeller Foundation, New York.

As far as is known *Anopheles quadrimaculatus,* the most important malaria vector in the United States, has been infected only with the three species of human

malaria parasite. It has been found, however, that an insectary strain of this species of mosquito is susceptible to *Plasmodium cynomolgi,* a monkey parasite native to the East Indies, and to *Plasmodium lophurae,* an avian parasite which probably originated in southeastern Asia. *P. cynomolgi* was isolated locally from a *Macacus cynomolgos* monkey. It has a 48 hour cycle of schizogony with enlargement of the red cell and conspicuous stippling and bears a close resemblance to *Plasmodium vivax.* Infectivity experiments with 735 mosquitoes revealed an average of 30 per cent stomach and gland infections with some lots as high as 85 per cent infected. It was possible to count 1080 oocysts on the stomach of one mosquito. The infection can be transferred to normal rhesus monkeys by the bite of infected mosquitoes. Human volunteers were not susceptible to the infection with either sporozoites or trophozoites. *Plasmodium lophurae,* isolated from a Borneo pheasant and pathogenic for the domestic chick, was also found to infect *A. quadrimaculatus.* Thus far infections are scanty, with a maximum of 40 oocysts per stomach. Twelve positive stomachs were obtained in 25 dissections. No transmission experiments have been concluded. It is believed that these findings represent the first instance where an anopheline mosquito has been found susceptible to an avian malaria parasite or where this particular species, *A. quadrimaculatus,* is capable of transmitting other than human malaria.

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